POWER

Volume 59 New York, June 3, 1924 *No.* 23

Who Will Pay for Muscle Shoals?

THE nitrate plants at Muscle Shoals were built because we had to have nitrates to make explosives for the war.

To furnish power for the operation of these plants, a great hydro-electric development was undertaken, auxiliary steam plants built, a limestone quarry and 4,200 acres of land acquired, over 300 permanent dwellings with bathrooms, electric service, etc. and a hotel with more than 100 rooms erected, 30-odd miles of improved streets and roads, nearly as many miles of sewers, a water works and miles of railroad tracks put down, and numerous buildings and shops constructed, besides those directly concerned in the nitrate processes.

In all it will have cost the Government over $150,000,000.

What is to be done with it?

Shall the Government finish it and keep it and run it, making nitrates for fertilizer and other purposes in times of peace so as to be a running concern in time of war?

Or shall it get somebody who has demonstrated his ability as an executive and industrialist to run it for these purposes?

Or shall it let somebody buy it at bargain-counter prices, as so much of the salvaged jetsam of the war has been bought?

Whoever buys it and whatever is paid for it, the fact should be kept in mind that it is his customers who will pay the bill!

Somebody making a product the price of which is uncontrolled, might be able to make the Government an attractive bid for it — but it would be the consumers of his product who would be reimbursing the Government for its outlay.

If somebody should take it and make fertilizer at a low cost and limited profit, the taxpayers generally would be paying for the advantage to the farmer. It might or might not be reflected, through the devious processes of preparation, trade and distribution, in cheapened food products. Any rent or amortization paid would increase the cost of fertilizer but relieve the taxpayer.

If it is sold or leased to a public utility, or if the Government operates it and sells its surplus power in block to those who have the organization and machinery for its distribution, the users of that current will profit, in case rates respond to lowered cost, if the Government sells the power cheaply.

In considering the relative merits of the various propositions received and to be submitted, the fact should be realized that the whole public is paying interest and depreciation on that $150,000,000, and the question should be asked: "Who would be paying it under the terms variously proposed?"

New Plant of American Seating Co. Burns Wood Refuse

Model 1,500-Kw. Industrial Plant Employing Condensing Turbo-Generators with Bleeder Connections To Balance Exhaust Steam Demands—High-Pressure Steam Supplied to Manufacturing Departments

QUITE recently the American Seating Co., of Grand Rapids, Mich., has completed a new power plant of modern design to supply the power and steam requirements for the making of theater and school furniture. At the same time the woodworking departments were electrified and the new plant was equipped with a view to balancing the power and heating steam. The fuel is wood refuse available from the mill departments, supplemented by coal when necessary.

Such a step was necessary, as the old power plant, dating back thirty years, had become obsolete and for some time inadequate, so that a portion of the power demand had to be met with purchased current and a growing business was enlarging the requirements.

In the old plant a 500-hp. non-condensing Corliss engine, through mechanical drives consisting of line-shafting and belting, supplied the power to the woodworking departments up to its capacity, and in addition it had been necessary to purchase current to meet the remainder of the load in the metal-working departments. Exhaust steam from the engine was used for heating the manufacturing buildings and for the drying of lumber. During the winter months all the exhaust steam was utilized and some steam supplied to the heating system at reduced pressure, but in summer, with the heating load off, a considerable portion of it was wasted to atmosphere. Four return-tubular boilers operating at 100 lb. pressure supplied steam to the engine, and at night live steam to the kilns and the heating service. The fuel, consisting of shavings and sawdust fired directly out of the collector system, was supplemented by coal, hand-fired. In addition to this equipment a small Scotch marine dry-back boiler had been installed to supply steam for baking enamels to the metal-finishing department.

Company Decides To Build New Plant

When the question of providing additional capacity came up, the first plan suggested was to revamp the old plant, replacing old equipment with new and adding to the old site as need be. Utilizing additional space, however, would have blocked extension of the manufacturing plant, and as the demands already exceeded the capacity of the power plant, it would have meant a considerable loss to shut down any of the equipment during the remodeling period. A probable loss of $100,000 in production while the interchange was being made was the big factor that finally decided the issue.

A new warehouse was needed, and with vacant property available across the street from the main works, it was decided that this should be the site for both the warehouse and a power plant, new from the ground up, with underground tunnel connections to the various points of service. In this location the plant could be arranged for economical production and convenience of operation, with plenty of room for expansion, the storage of coal and the provision of a cooling pond for condenser water. This, of course, meant electrification of the mill, but this was not a serious undertaking, as for ten years back the machinery had been arranged with this end in view. In general the various machines had been arranged for group driving with the exception of the planers, routers and other heavy machines, so that it was easy to transfer the belt connections from the line-shaft to the motors and, where individual motor drive had been employed, to substitute new 60-cycle motors for the old 30-cycle machines supplied from station service. This change was deemed advisable by the engineers owing to the advantages offered by 60-cycle motors in the operation of woodworking machinery, the lower motor cost and the ability to purchase these motors from stock. It was their belief that it was only a question of time before the service company would arrange to furnish 60-cycle current.

The Heating Load a Dominant Factor

From the data available on the various services it became evident that the heating load would be a major factor in the design of the power plant. With the addition of the new warehouse, the heating aggregated 68,000 sq.ft. of direct radiation, 17,210 sq.ft. being in the drying kilns and the remainder in a two-pipe vacuum heating system serving the manufacturing plant. In addition, live steam at 35 lb. pressure had to be supplied for glue cooking and steam at boiler pressure to the metal-finishing department. Exhaust steam was to be utilized for the heating, and it was necessary to choose equipment with a view toward securing a balance between the demand and the supply of exhaust steam. Securing such a balance was complicated by the fact that the heating load was on for the full 168 hours of a seven-day week, whereas only fifty of these hours constituted the running or operating period for the main power load. Through the day the power and lighting load ranged from 500 to 700 kw., with swings up to 900 kw. during the busy season and prospects for an increasing load with the growth of the business.

In the accompanying illustrations is shown the plant that is now supplying these services. As indicated in Fig. 3, it is housed in an attractive brick structure, separated into distinct buildings for the boilers and turbines to give plenty of light and ventilation, with a low interconnecting structure housing the feed-water heater, pumps, etc., and a reinforced-concrete stack at the center of the areaway between the buildings. The new warehouse is also shown in this view and the spray pond. The building construction throughout is substantial, the interior finish attractive, and in the maintenance of the plant cleanliness is the watchword.

At present the boiler house is equipped with three

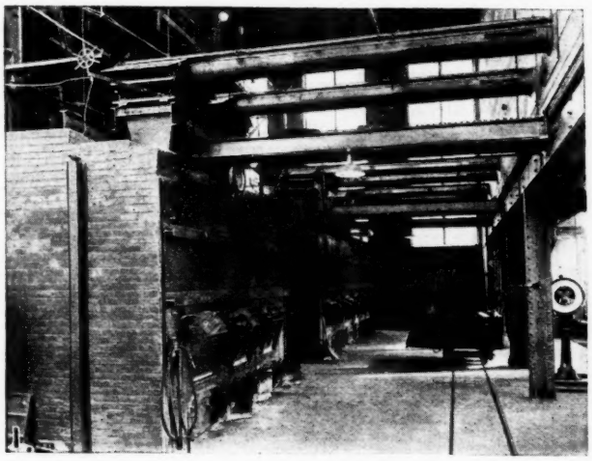


Fig. 1—Boilers and sawdust conveyors

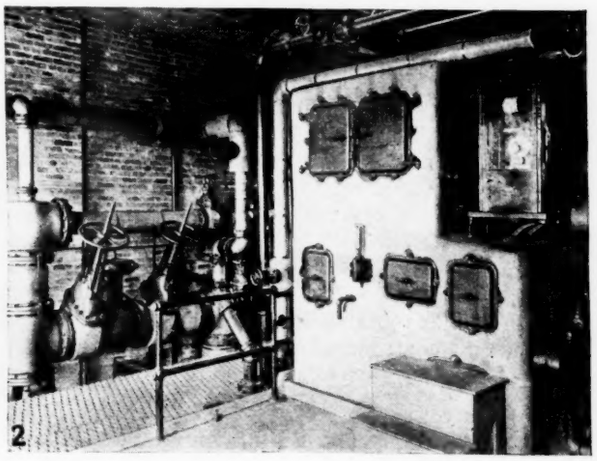


Fig. 2—Open feed-water heater

Fig. 3—New warehouse and power station in backround

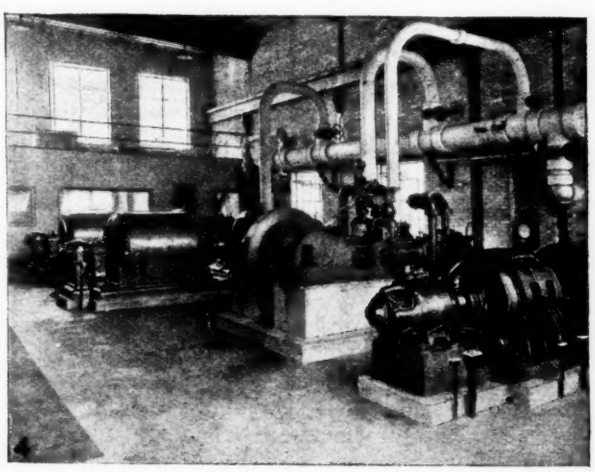


Fig. 4—Turbine room with main generating units

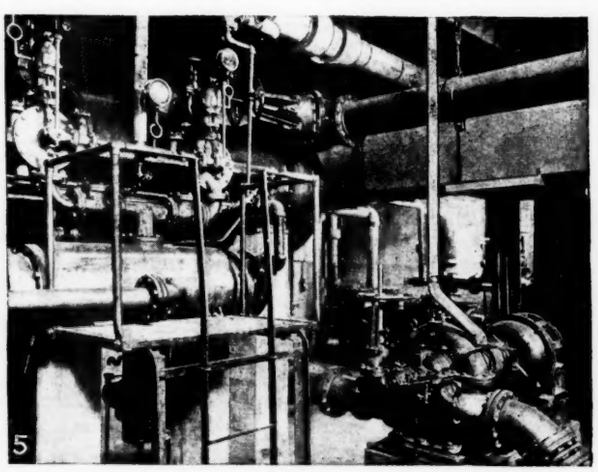


Fig. 5—Surface condenser installation

units of 4,000-sq.ft. each, with space for a fourth to complete a second battery of two boilers. The operating pressure is 165 lb. gage, and the steam is superheated 70 deg. by a superheater within the casing in front of the boiler tubes. The boilers are of the two-pass vertical type served by Dutch ovens with ordinary herringbone grates having ½-in. openings. The furnace roof is a flat suspended arch sloping upward toward the rear and inclosing a combustion volume approximating 840 cu.ft., or 0.21 cu.ft. per square foot of boiler-heating surface.

From the bottom of each boiler the gas outlet swings upward into a breeching about 18 ft. above the boiler-room floor, which at a point midway of its length turns through the boiler-room wall into the stack, this having been placed on a center line between what will eventually

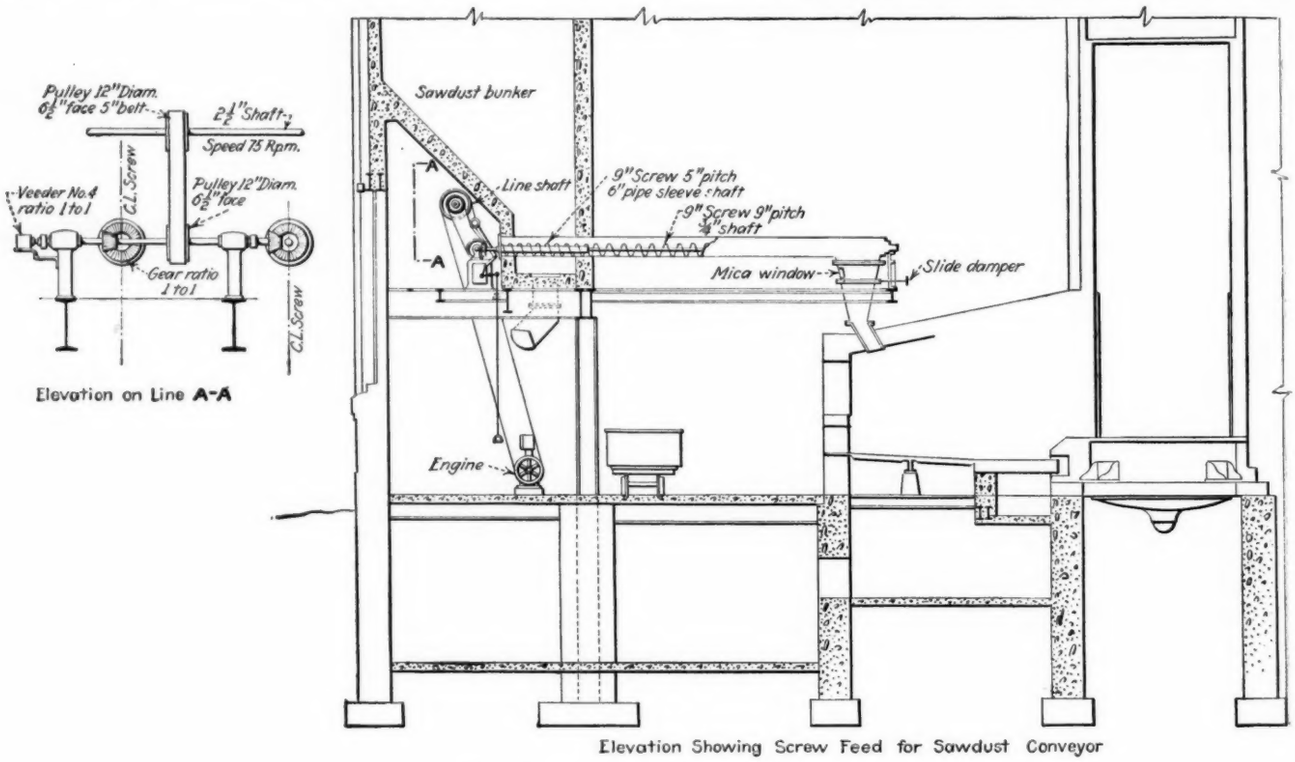


Fig. 6—Diagram of conveyor drive

be two batteries of boilers. The stack rests on a foundation carried to hardpan, rises 175 ft. above the grates and at the top is 9 ft. in diameter. For 60 ft. of its height it is lined with common brick.

It has been indicated previously that a sufficient quantity of sawdust, shavings and solid wood passed through a shredding machine is available to carry the bulk of the load. From the cyclone of the collecting system this material is blown to the power plant, a distance of 500 ft., through an 18-in. pipe discharging onto a scraper conveyor. Through gates in the bottom of the conveyor trough the material is delivered into any one of five concrete storage bins, one for each of the present boilers, one for the future boiler, and a spare bin from which delivery may be made into a car on the boiler-room floor and the sawdust wheeled directly to the furnace, this provision being made as a safeguard against accident to any one of the screw conveyors feeding the boilers in operation. The bottom of each bunker is pitched toward the front with a pocket at the lowest point through which two screw conveyors pass horizontally to feed boxes on top of the furnace of each boiler. These feed boxes are provided with gates to close the feed openings when burning coal and have mica glazed peekholes so that the operator may observe the rate of feeding sawdust. The material delivered by the screw drops down into the furnace, the feed being regulated so that most of it burns in suspension, the remainder dropping in small cone-shaped piles on the grate which burn almost as rapidly as they form. To eliminate smoke, the air for combustion is admitted through the firing doors at the front of the furnace, while the ashpit doors are practically closed.

During the summer there is sufficient waste material to meet all demands, but in the heating season coal is burned at night, and through the day, if there is a shortage of material, a thin bed of coal is carried on the grates, from which a coal fire will pick up quickly should a change to this fuel be necessary. In December last, 175 tons of coal was burned, and in January and February the coal requirements exceeded 500 tons per month.

In connection with the sawdust feed some interesting experience developed at the new plant. It will be recognized, of course, that the mechanism employed cannot be standardized commercially and that at each plant some experimentation will be required, depending upon the length of the screw conveyors and the size and consistency of the waste material. Originally, each conveyor was equipped with a friction drive disk which was turned by a paper friction wheel placed at right angles to the disk and adjustable radially for different speeds to meet the requirements of the individual boilers. The main driving shaft was operated by a steam engine under automatic control to change the rate of feed in accordance with the steam pressure. In this regulation, however, there was too great a lag to insure constant steam pressure and certain other difficulties arose

which made some changes desirable. With screw conveyors approximately 21 ft. long there was not enough surface in the friction drive to prevent stoppages from small obstructions getting into the conveyor trough. Also, the wheels wore out rapidly and it was found that it would be desirable to reduce the feed at the receiving end of the conveyors. Accordingly, in that portion of the conveyor passing through the bin, the pitch of the 9-in. screw was reduced from 9 to 5 in., and the center filled with a 6-in. pipe core. No change was made in the remainder of the conveyor, consisting of a screw of 9-in. diameter, 9-in. pitch and 1½-in. shaft. This relieved the former congestion and the tendency to clog.

New Drive Arrangement Adopted

The friction drive, which in the past had worked most satisfactorily with shorter runs of conveyor, was discarded and the following drive arrangement substituted: Each screw conveyor is connected through beveled gears to a jackshaft which is driven by belt from a mainshaft from which all the conveyors are operated. The jackshaft can be stopped by lifting a belt tightener which, when the conveyor is in operation, forces the belt against the driving pulley on the main lineshaft. This is done from the boiler-room floor by means of a push-and-pull lever with a bell-crank arrangement to hold the idler off the belt as long as desired.

The source of power is the same vertical engine belted to the main lineshaft and mounted on the boiler-room floor under the eye of the fireman. By means of a quick-closing throttle valve the speed of the engine can be varied by hand, and in turn the rate at which the fuel is fed, in accordance with variations in the steam pressure. Charts from the steam-flow meter show that the boiler pressure has been maintained in this way within a range of 3 lb. The entire system is now working most satisfactorily and giving highly economical results when the character of the fuel is considered.

The possibilities with this fuel are indicated by a 14½-hour test made on March 17. From meter readings an average evaporation of approximately 4 lb. of water per pound of wood refuse was obtained. The refuse was of good quality and probably averaged about 5,400 B.t.u. per pound.

Finding Weight of Fuel Burned

To get the weight of the fuel burned, a screw conveyor was calibrated by discharging it into a dead furnace for 100 revolutions. The operation was repeated several times, and upon each occasion the material was weighed and reduced to the quantity delivered per revolution of the screw. Then by placing counters on the conveyors and watching to see that they were kept full at all times, it was an easy matter to compute the total quantity of fuel delivered. Meter readings gave the total quantity of water, and by dividing one quantity by the other the evaporation per pound of refuse was obtained.

Comparative figures on a strictly coal basis were obtained during the shutdown period from Dec. 14 to Dec. 31 for inventory and repairs to the manufacturing plant. West Virginia lump coal containing about 14,000 B.t.u. per lb. is used at the plant. During this entire period the V-notch meter chart and the coal weights indicated an average evaporation of 9.1 lb. of water per pound of coal as fired.

Yard storage for coal is provided adjacent to the boiler room in a walled-in space having capacity for 1,800 tons. As the storage space is parallel to the street, appearances are greatly improved by concrete boundary walls with pebble finish and brick trimming. At present the coal is unloaded by hand from railway cars, but a more modern labor-saving method is one of the plans for the future. An industrial track swinging on a pivot to any point in the storage space is provided and industrial cars carry the coal into the boiler room.

Feed Water Mostly Condensate

As all returns are brought back from the mill, the boiler feed water is mostly condensate. About 10 per cent makeup is required, and this is drawn from the spray pond back of the plant. Three reciprocating vacuum pumps equipped with vacuum governors to

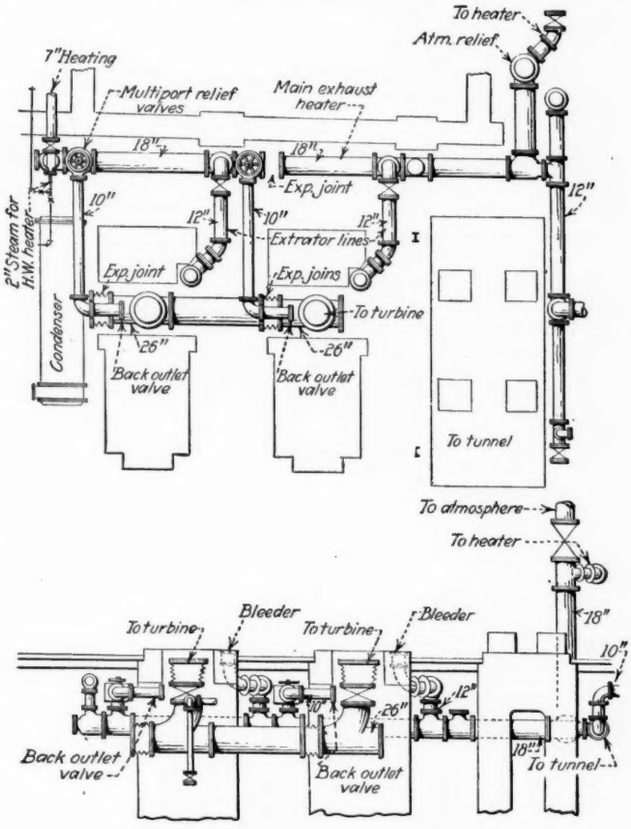


Fig. 7—Low-pressure exhaust piping

maintain a vacuum of about 10 in., and automatic sprays deliver the returns to a receiving tank about 25 ft. above the boiler-feed pumps on the basement floor. From the receiving tank delivery is made by gravity under float control to an open heater at a level 10 ft. below the receiving tank, which provides a head of approximately 15 ft. on the boiler-feed pumps. There are two of these pumps of the outside-packed, simplex type, each having sufficient capacity to meet the present requirements.

Makeup water is raised from the pond to the receiving tank by a reciprocating steam pump under the control of a pump governor regulated by the head in the tank. As a final reserve this same tank has connection to the city water mains under float control. Water from the receiving tank is used also for turbine gland and air-compressor cooling, the discharge from the machines

going to the spray pond, so that there is no wastage of soft water. From the pumps double feed lines supply the boilers, one line being equipped with automatic control and the auxiliary line for hand operation.

To care for the power and lighting loads, there are two main generating units with space for a third machine at a future date. The prime movers are steam turbines of the bleeder type, driving at 3,600 r.p.m., 750-kw. generators, with direct-connected exciters.

One condenser serves the two turbines. It is of the surface type, equipped with steam-jet air pumps and motor-driven circulating and condensate pumps. Back-outlet gate valves in the turbine connections to the main provide for relief to the main low-pressure exhaust line of the plant. The extraction lines and the exhaust from other steam-using equipment in the plant also lead into this exhaust main, in which the pressure ranges from 2½ to 3½ lb. gage. Connections to the feed-water heater, atmospheric relief and to the mill supply are indicated in the low-pressure piping drawing, Fig. 7.

Through a screened inlet the circulating pump draws the water from the pond, passes it through the condenser and back to the pond through ten 5-nozzle spray groups. To replace evaporation and add to the supply of soft water, the roof drainage from the power plant and the large warehouse adjacent is collected and delivered to the pond

Turbo-Generator for Night and Holiday Loads

In the turbine room a 50-kw., non-condensing turbo-generator has been provided to care for night and holiday loads and during the winter months to be used in the capacity of a reducing valve to help meet the demand for exhaust steam. The bleeder turbines are called upon to maintain a balance, and in case of need during the night, live steam may be used to supplement the supply of exhaust available.

Other equipment in the turbine room is a two-stage intercooling air compressor which supplies compressed air at 90 lb. presure to the manufacturing plant. The exhaust of this machine adds materially to the supply of low-pressure steam.

Sixteen Panel Switchboard

In a built-in recess is the switchboard with sixteen panels equipped with the usual instruments and hand-operated switching equipment. The feeder circuits take off at generator voltage, except for the lighting service, which is stepped down to 120 volts, and inclosed in armored conduit, are carried through the tunnels to the various buildings.

Fig. 8 shows the arrangement of the high-pressure steam piping as well as the pump and feed-water piping

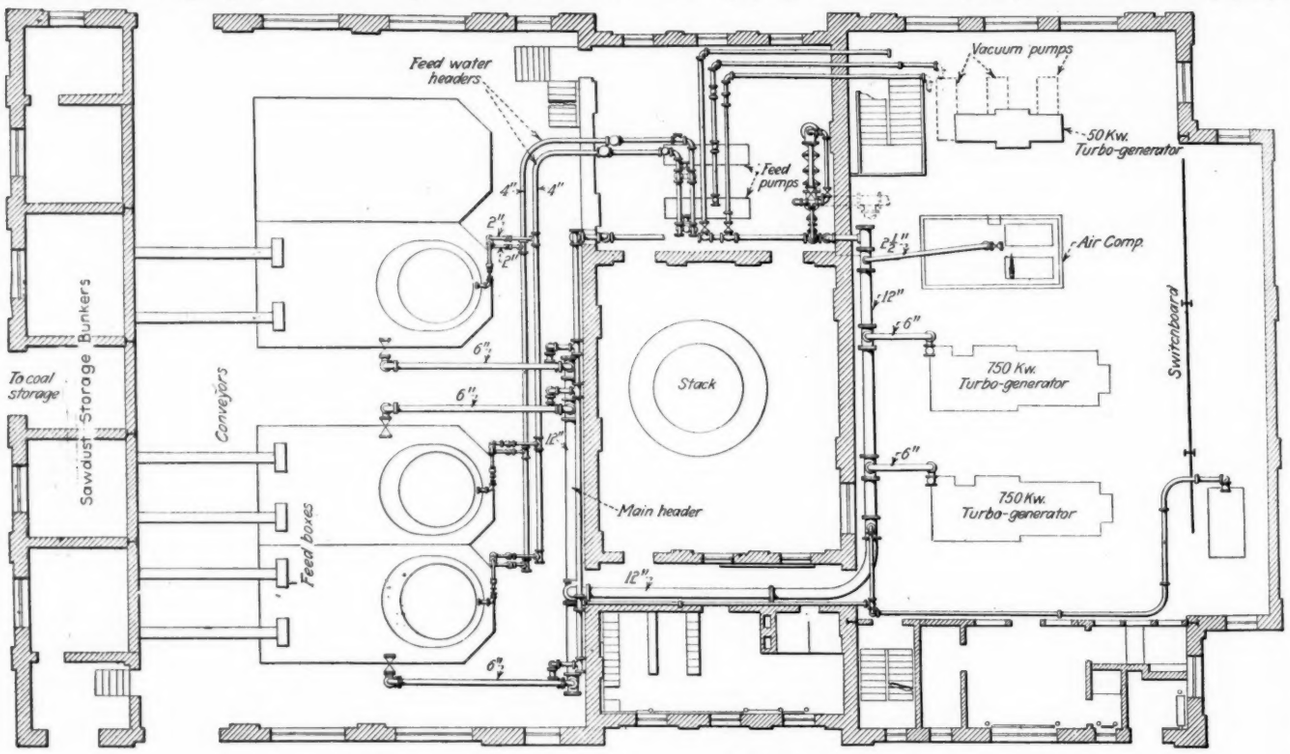


Fig. 8—High-pressure steam and feed-water piping

to the boilers. From the boilers 6-in. leads pass into a 12-in. boiler-room header which is carried over to the turbine room and for its full length supported on wall brackets. At either end of the main header connection is made to a 6-in. auxiliary header which supplies the various pumps and the 50-kw. non-condensing turbo-generator.

In the blowoff piping a safety feature worthy of mention has been introduced. Each boiler discharges to a common blowoff line of 4-in. diameter leading to a vented blowoff basin from which the water passes through a cooling basin to the sewer. Between each boiler and the blowoff main is the usual plug cock and the blowoff valve. In addition, there is an extra-heavy swing check valve inserted between the cock and the blowoff valve to guard automatically against blowdowns entering an empty boiler and perhaps scalding men at work on the interior. Such accidents have happened in the past when the blowoff valve and cock have been left open inadvertently. The heavy check valve mentioned is a safeguard well worth adopting.

For a plant of the size an unusually complete complement of instruments are in use. A track scale weighing the industrial cars on their way to the boilers gives the coal weight. A V-notch meter measures the feed water. Each boiler is equipped with a combination steam-flow and draft indicating meter. The indicating instrument is of the multi-pointer type, mounted on the top of the furnace, with a dial curving back and down from the top edge so that the readings are more easily discernible from the boiler-room floor. The main header is provided with flow and pressure recording and integrating meters for the total steam generated. Other flow meters show the steam to the auxiliaries, including the non-condensing turbine supply as well as live steam to the manufacturing plant, and the steam bled from the main units. Recording thermometers show the temperature of the flue gases to the stack and the incoming and outgoing temperatures of the condenser circulating water. A recording thermometer is also on the blowoff line, but its service is primarily to check the blowdown periods and to indicate leaky blowoff valves. For testing purposes the plant has a complete set of portable instruments.

Economy of New Plant

As the new plant has been operating for several months, some interesting data are available tending to show the improved economy and the cost of the power and heating services. In comparing the month of October in 1923 with the same period in 1922, it was found that the items of purchased electricity, fuel, labor and attendance amounted to $3,737.43 in the former period and $3,106.93 for October, 1922. The increased cost, amounting to $630.50, was partly absorbed by an increase of 27c. per ton for coal and is turned into a comparatively large saving when the increase in load is considered. For example, the floor space to be heated in the manufacturing and storage departments had been increased 45 per cent applying in the same ratio to the direct radiation provided. The connected load in the old plant was 933 hp., including 30-cycle motors and the old steam engine which drove most of the machines in the factory through belt and lineshaft transmission systems.

The connected load now totals 1,626 hp., indicating an increase of 74 per cent. The lighting load has grown from 61 to 89 kw., an increase of 45.8 per cent, the compressed-air capacity is now 450 cu.ft. per min. as compared to 90 cu.ft., and the steam to the japanning ovens has risen from 1,500 to 2,400 lb. per hour, an increase of 60 per cent. Incidentally, the last item showed a saving of over $40 per day, due to the fact that it is possible to bake the enameled metal parts in one hour with the high-temperature steam now available, as compared to the two hours formerly taken. A better product was secured, and it was possible to transfer a number of men from the metal-finishing department. Estimated on a basis of 200 days per year, an annual saving of $8,000 was effected that had not been anticipated.

For the design of the new plant and the building housing it, credit is due Neiler, Rich & Company, consulting engineers, of Chicago, who worked in close cooperation with R. K. Merrill, mechanical engineer for the company. W. M. Gormley is chief engineer of the plant.

PRINCIPAL MECHANICAL EQUIPMENT IN POWER PLANT OF AMERICAN SEATING COMPANY

BOILERS

Manufacturer	Wickes Boiler Co.
Type	Vertical Water-Tube
Number installed	3
Heating surface each, sq.ft.	4,000
Superheater (Foster)	Power Specialty Co.
Steam pressure, lb. gage	170
Superheat, deg. F.	70
Grate (herringbone), sq.ft.	69
Ratio grate area to steam-making surface	1 to 58
Arch, flat suspended	M. H. Detrick Co.
Furnace volume, cu.ft.	480
Furnace volume, cu.ft. per sq.ft. heating surface	0.21
Fuel—wood refuse supplemented by 14,000-B.t.u. W. Va. Coal	
Sawdust screw conveyors, 21 ft. long, 9 in. diam.	Link-Belt Co.
Drive, vertical engine, 8x8 in.	Engberg's Elec. & Mech. Works
Scraper conveyor over storage bins	Link-Belt Co.
Drive, 5-hp. belted motor	Howell Mfg. Co.
Industrial cars, coal	Koppel Co.
Mono-rail electric hoists, ashes	Alfred Box Co.
Coal scale	Toledo Scale Co.

CHIMNEY

Builder	General Concrete Construction Co.
Type	Reinforced-concrete
Number	1
Diameter at top, ft.	9
Height above grate, ft.	175

FEED-WATER HEATER

Manufacturer	Warren Webster & Co.
Number	1
Type	Open
Capacity, lb. per hr.	55,000
Feed water measurement (Lea V-notch meter)	Yarnall-Waring Co.

BOILER FEED PUMPS

Manufacturer	American Steam Pump Co.
Number	2
Type	Outside packed, simplex
Size, in.,	14x8½x12

VACUUM PUMPS

Manufacturer	American Steam Pump Co.
Number	3
Size, in.	8x12x12
Vacuum governor and aut. spraying device	Bolyston Steam Spec. Co.

MISCELLANEOUS PUMPS

Service, direct-acting	American Steam Pump Co.
Control, pump governor	Fisher Governor Co.
Fire pump, Underwriters, 1,000 g.p.m.	Fairbanks, Morse & Co.

AIR COMPRESSOR

Manufacturer	Bury Compressor Co.
Type	Two-stage, intercooling
Size, in.	9x15x9x10
Air supply, pressure, lb. gage	90

GENERATING UNITS

Rating, kw.	750
Number	2
Turbine, bleeder type	Kerr Turbine Co.
Generator, 480-v. 3-ph. 60-cycle	Allis-Chalmers Mfg. Co.
Exciter, direct connected, kw.	8
Speed, r.p.m.	3,600
Surface condenser, one	C. H. Wheeler Mfg. Co.
Surface, sq.ft.	2,260
Air pump	Two-unit Radojet
Circulating pump, g.p.m.	2,000
Drive, 900 r.p.m., 30-hp. motor	Howell Mfg. Co.
Condensate pump, g.p.m.	40
Drive, 1,800 r.p.m., 5-hp. motor	Howell Mfg. Co.
Spray system, 10 five-nozzle groups	Spray Engineering Co.
Non-condensing unit, kw.	50
Turbine	Kerr Turbine Co.
Generator, 480-v. 3-ph. 60-cycle	Allis-Chalmers Mfg. Co.
Exciter, direct-connected, kw.	17.5
Speed, r.p.m.	1,200
Switchboard, 16-panel	Westinghouse Elec. & Mfg. Co.

MISCELLANEOUS EQUIPMENT

Crane, 10-ton hand	Chisholm & Moore Mfg. Co.
Soot blowers	Vulcan Soot Cleaner Co.
Non-return valves	New Bedford Valve Mfg. Co.
Safety valves	Crane Co.
Plug cocks and Y blowoff valves	Crane Co.
Swing check valves	Crane Co.
Steam and water valves	Crane Co. and Boylston Steam Spec. Co.
Back outlet valves	C. H. Wheeler Mfg. Co.
Multiported relief valves	Cochrane Corp.
Atmospheric relief valve	Cochrane Corp.
Expansion joints	Groen Mfg. Co.
Piping	Pittsburgh Piping & Equipt. Co.
Pipe covering	Richards Mfg. Co.
Steam traps	Boylston Steam Spec. Co.
Feed-water regulators	"S-C" Regulator Mfg. Co.
Water gages	Jerguson Gage & Valve Co.
Steam-flow and air meters	Bailey Meter Co.
Steam-pressure gages	Marshalltown Mfg. Co.
Recording pressure gages	Bristol Co.
Recording thermometers	Foxboro Company; American Schaeffer & Budenberg Corp.
Set of portable testing meters	Esterline-Angus Co.

The Diagnosis of Diesel-Engine Defects From Indicator Diagrams

By R. C. MELROSE

THE Diesel engine lends itself admirably to the diagnosis of trouble by the study of indicator diagrams. In actual practice the conditions as shown on the theoretical diagram in Fig. 1 are not obtainable for the following reasons:

1. The water circulating in the jacket, cylinder head, and piston absorb heat during compression and expansion, causing both curves to fall.

2. Particles of oil are still burning after the fuel valve is closed; the general tendency of this condition is to reduce the pressure during the combustion period and raise the expansion curve. This is called "after burning," and although some think the effect is beneficial as it increases the mean effective pressure, it is actually a disadvantage in that the fuel consumption per brake horsepower is increased, and carbon troubles occur.

3. The combination of oxygen, carbon, and hydrogen does not remain constant, consequently the expansion curve tends to flatten out. With the theoretical diagram a perfect gas is assumed, the specific heat of which is constant.

4. Mechanical defects such as leaking piston rings, exhaust valves, air inlet valves, fuel valves and air starting valves, etc.

5. The effect of high piston speed on volumetric and scavenging efficiencies.

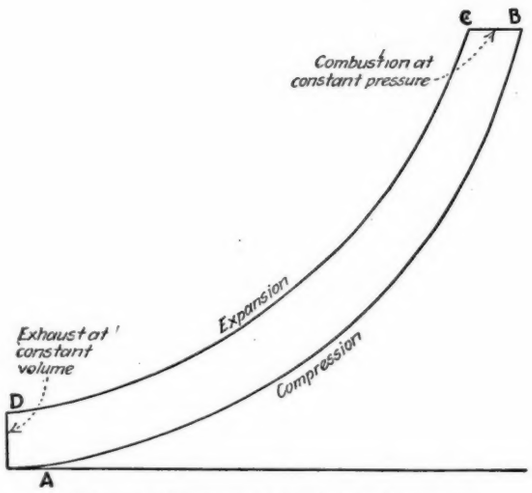


Fig. 1—Theoretical Diesel diagram

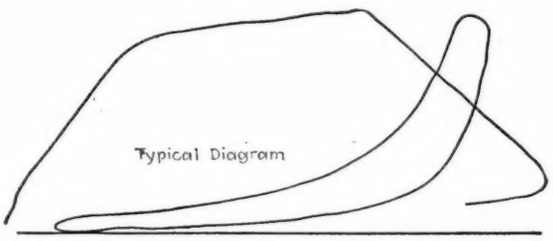


Fig. 2—Typical diagram from Diesel engine

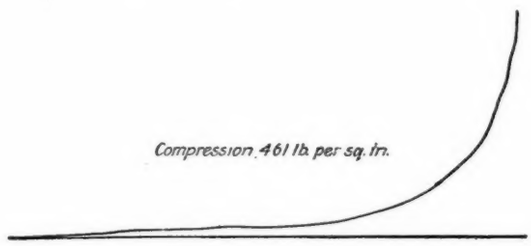


Fig. 3—Compression diagram with fuel cut out

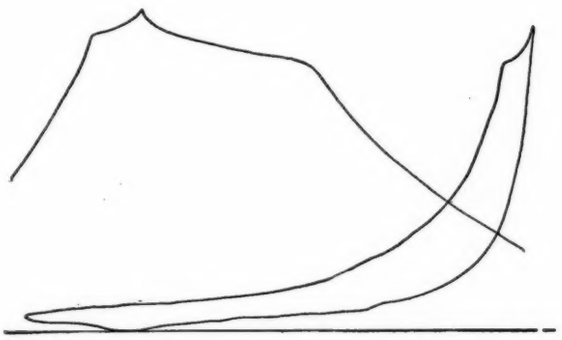


Fig. 4—Diagram showing leaky fuel valve

Diagrams from Working Engines

Fig. 2 shows a diagram taken from a four-stroke-cycle engine and may be accepted as representing good practice. The curved line above the diagram is known as a "draw curve" and is obtained by pulling the indicator cord by hand. By means of this draw curve we can measure the pressure of compression and maximum point of ignition with approximate accuracy. The cylinder is shown to withstand a compression pressure of 467 lb. per sq.in. and a maximum firing pressure of 525.4 lb. per sq.in. The mean effective pressure works out to 90.88 lb. per sq.in.

The diagram in Fig. 3 shows a cylinder with the fuel and blast air shut off, and from it many defects can be deduced. Assuming that the piston rings are tight and that all valves are free from leakage, the expansion curve should cover the compression curve and both appear as one, as the difference due to the heat given up to the jacket cooling water will not show on such a small scale. If the cylinder shows reluctance to start firing when starting up from cold, as soon as the engine is under way the engineer should take a diagram with the fuel and blast shut off and observe how the expansion and compression curves show on the diagram. If they cover each other but do not reach the desired pressure necessary to give positive firing, then the clearance between the piston and cylinder head will have to be reduced. This adjustment will have to be carried out with great care as a small reduction in clearance makes a big difference in the terminal pres-

sure. If the expansion curve falls below the compression curve and the maximum pressure is shown to be below that necessary for firing, one is safe in assuming that the piston rings, exhaust or air inlet valves are leaking. In some engines where the starting air is not automatically shut off when the engine picks up on fuel, a leaking air starting valve may show the expansion curve above the compression curve. Care must be taken to ascertain that there is no lost motion in the indicator gear due to slackness, as this will show the same defects on the diagram as that due to leakage, with this exception, that with slack gear and tight rings and valves the pressure will be observed to be correct on measuring the card.

Checking Cylinder Leaks

If the piston rings are leaking badly, the operator soon becomes aware of the fact by the pungent odor of burnt gases, but a cylinder head leaking at the joint sometimes produces the same results. Therefore the best method to employ in locating the source of leakage is as follows: After the engine is shut down, connect up the turning gear to prevent the engine from turning and run blast air into the cylinder by levering open the fuel valve. By listening at the bottom of the cylinder —they are generally open at the bottom—air will be heard escaping if the piston rings are leaking. If the rings are in good condition, disconnect the exhaust pipe between the valve and exhaust manifold. If no signs of

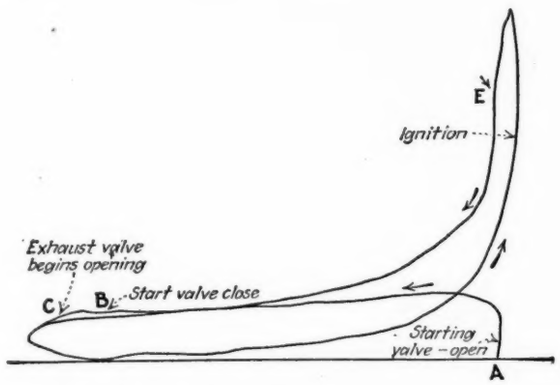


Fig. 5—Abnormal pressures due to starting air

leakage are detected here, then do the same with the air inlet valve. With certain makes of engine this procedure is necessary as the cylinder head has to be removed in order to withdraw an exhaust or air inlet valve, so it is best to test them in the manner described.

There are other leaks that do not show on a diagram unless very serious, such as a cracked cylinder head. There are quite a large number of cracked heads in commission, as the crack generally closes up when the engine is running, but the point to guard against is the filling up of the cylinder with water when the engine is stopped and the head, by cooling, opening up the crack. A cracked piston can easily be detected, as the gases leak through the cracks and can be seen emerging from the piston cooling-water discharge pipe.

Fig. 4 shows a diagram taken from a cylinder where the fuel valve was leaking. Faulty timing or too small roller clearance will give somewhat similar results, the general consequences being preignition and an abnormal maximum pressure. This condition usually causes a distinct detonation and should be attended to immediately. Vibration of the engine sometimes causes the adjusting screws on the valve levers to work back, with the result that the valves cannot seat because the rollers bear on the cam all the time. When a valve is seating properly, the spring will be observed to give a sharp tremble. When roller clearances are taken, see that the slack motion between roller and valve is taken up or a false reading will be obtained.

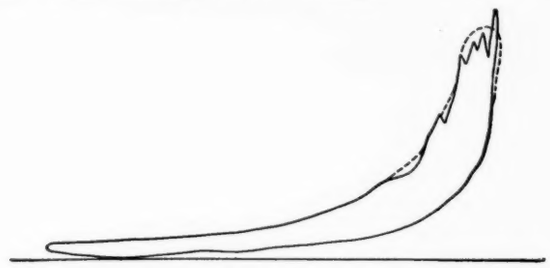


Fig. 6—Combustion is incomplete

A condition where the cylinder has been primed with oil previous to starting is illustrated in Fig. 5, showing the starting air diagram and the first firing diagram on the same card. This shows the abnormal pressures sometimes obtained due to injudicious priming, and is generally the cause of the relief valves lifting when starting up. Priming should be resorted to with discretion. The writer once saw a relief valve, casing and all, blown clean out due to an overdose of kerosene injected through the indicator cock with a syringe previous to starting up.

A Prevalent Condition

Fig. 6 shows a wavy combustion line due to incomplete atomization. This was caused by the oil not being sufficiently broken up when entering the cylinder, each lump firing separately and at different periods, causing the pressure to jump up with each explosion. This is also a cause of after burning. Staggering the holes in the pulverizer rings will often cure this defect without any further alteration. Defects of the combustion line on a diagram are usually noted when changing

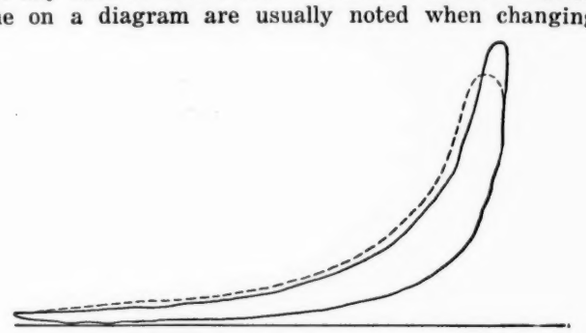


Fig. 7—Pulverizer needs more resistence

from one grade of oil to another without altering the pulverizer accordingly.

The result of having the fuel valve with correct opening but too little resistance in the pulverizer, is shown in Fig. 7. To correct this it will be necessary to give less lift or put one more ring in the pulverizer. This diagram shows a high maximum pressure and is a nearer approach to a condition of constant volume than constant pressure. In changing from a heavy to a light oil, this kind of diagram is often obtained.

Pulverized-Fuel Systems—I

By A. L. COLE

This is the first of a series of articles describing the different types of equipment now in general use for drying, pulverizing, transporting and burning coal in pulverized form. In view of the progressive development now going on in this class of equipment and the art of burning pulverized coal in the furnace, some of the present day types and methods are presented.

THE first mention of pulverized coal dates back to about 1824, at which time attempts were made to utilize coal in pulverized form in connection with metallurgical processes.

Experiments were conducted in England in 1831 by J. S. Dawes, who tried it out in blast furnaces by injecting it with the air through the tuyeres. Other experiments along the same line were conducted by Desbois-sierres in 1846, by Monchel in 1854 and by Mushet in 1856. During 1867 and 1868 tests were made by naval engineers at South Boston on firing a boiler in part with pulverized coal. The boiler used was of the horizontal two-flue type having approximately 300 sq.ft. of heating surface and 13½ sq.ft. of grate surface. A coal fire was maintained on the grate and the pulverized-fuel fed in above it, a fire arch being used to maintain the furnace temperature when the powdered fuel was used. About the same time a number of experiments were also carried out by T. R. Crampton, of London, on firing stationary and locomotive boilers with pulverized coal.

Little progress, however, was made in the application of this fuel until about 1894, when it was first successfully utilized for the burning of cement rock in rotary kilns of the cement industry. From that time on its use in this particular industry has extended until now over 90 per cent of the total cement output is made with this form of fuel. Its use has also gradually broadened until it is now being employed extensively in other major industries.

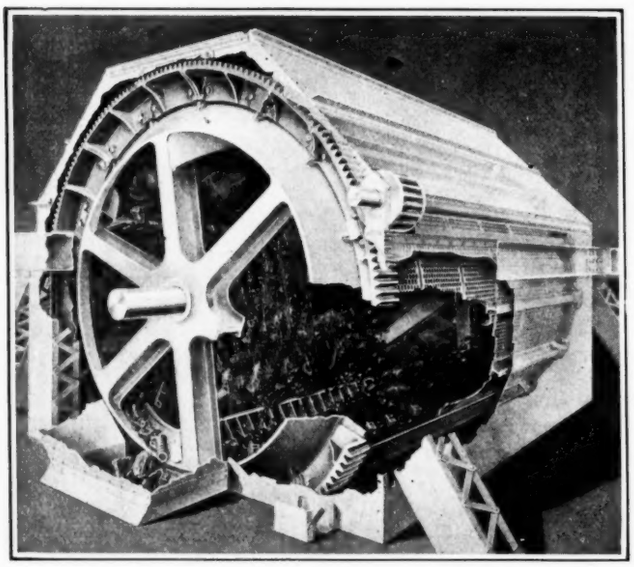
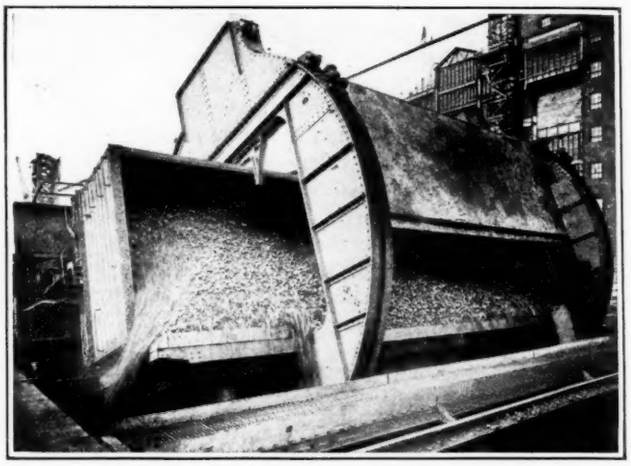


Fig. 1—Bradford breaker reduces lump coal to proper size for pulverizing



Although the use of pulverized fuel is no new development in the cement industry, only within recent years has it been applied successfully to boilers. In the early attempts to use pulverized coal in boilers, difficulty was experienced owing to the high furnace temperatures, and practically all the early installations gave a great deal of trouble due to melting down of the brickwork and other rapid deterioration of the furnace.

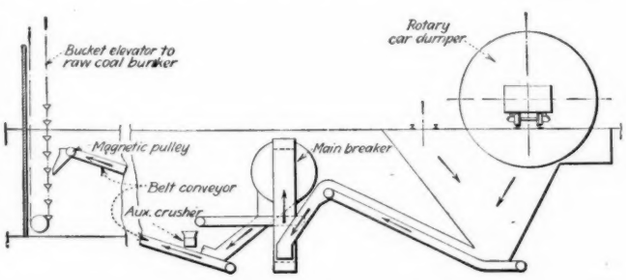


Fig. 2—General arrangement of rotary car dumper, breaker, magnetic separator and conveyors

One of the earliest power-plant installations and one in which much pioneer work was done was the Oneida Street plant of the Milwaukee Electric Railway and Light Co. The boiler on which the experiments were carried out was a three-pass vertically baffled horizonal water-tube having 4,685 sq.ft. of heating surface. The furnace, which was originally installed in 1898 for burning bituminous coal, was extended out a few feet in front to provide a mixing chamber, and with the removal of the stoker the ashpit was utilized as combustion space. The furnace volume was approximately 1,700 cu.ft., allowing at normal rating of the boiler slightly less than 1 cu.ft. of volume per pound of coal burned per hour, or approximately 4 cu.ft. of furnace volume per 10 sq.ft. of steam making surface.

The excellent result of 81 per cent net efficiency obtained on this installation and the later decision of this company to use pulverized coal exclusively in its Lakeside station gave considerable impetus to the adoption of pulverized fuel for stationary boilers.

Although a comparatively large number of pulverized-fuel installations have been made during the last few years under widely varying conditions and the burning equipments as well as the design of the furnace have changed materially, in the opinion of many engineers pulverized fuel equipment and the art of burning this fuel under boilers is still in a state of flux and subject to a number of refinements and adjustments, no one method having as yet become standard. Undoubtedly, there still remains the possibility of a great amount of development on the engineering and mechanical features of each type of installation.

In view of the rapid development that is now being made in equipment to burn coal in pulverized form and the art of burning it in the furnace, it is with the object of presenting the different types of apparatus now in general use and their principles of application that this series of articles is written.

The present total consumption of pulverized coal for all purposes in this country is over 20,000,000 tons per year. This represents an increase of practically 100 per cent in the last four years. When the plants now under construction and contracted for are completed and in operation, the total tonnage will have increased by approximately 20 per cent.

In general it might be said that a pulverized-coal plant consists of the necessary pieces of equipment to convert the raw coal into powder and convey it to the furnace as required according to the demand for steam upon the boiler. In the furnace the coal is burned in suspension, the necessary air for combustion being supplied with the coal through the burner or part with the coal and the rest through opening in the furnace walls.

There are two systems in general use: (1) The unit system, in which one machine receives the raw coal without drying, pulverizes and delivers it to the furnace with the necessary air for combustion to burn it; (2) the storage, or multiple, system in which the coal is prepared in a separate building or separate compartment of the main boiler-house structure and is stored in bins until required.

The unit system at the present time is used principally in the smaller plants and for firing isolated furnace or boilers, while the multiple system is especially adapted to large installations where the daily consumption runs into the hundreds of tons or is sufficiently high to warrant a centralized preparation plant. The general features and relative merits of these two systems will be treated in succeeding articles.

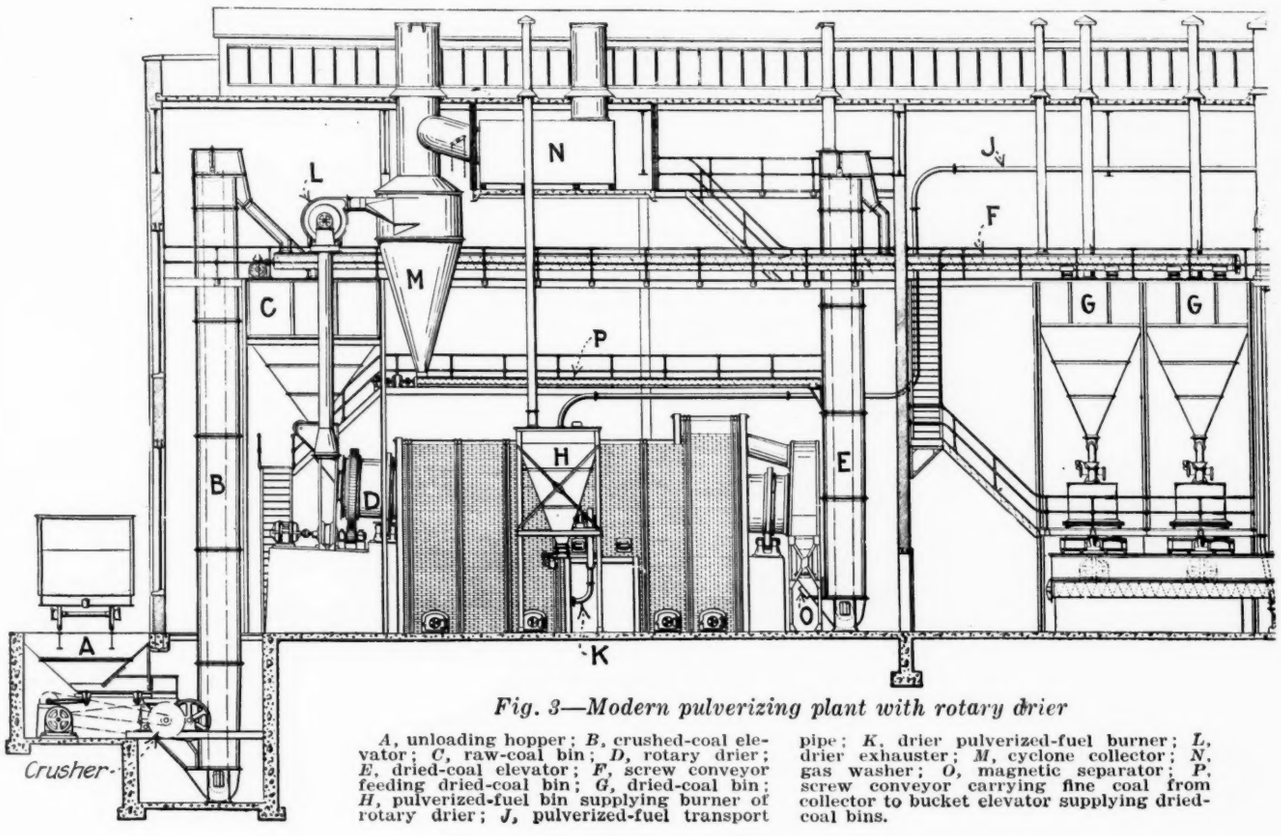
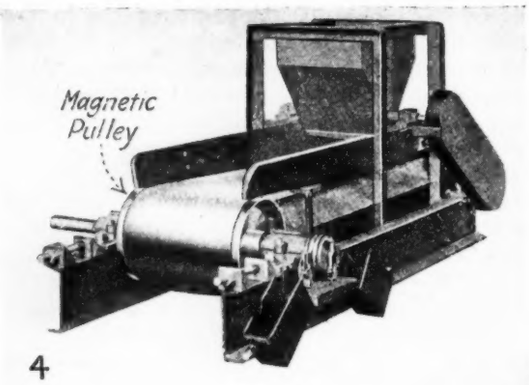


Fig. 3—Modern pulverizing plant with rotary drier

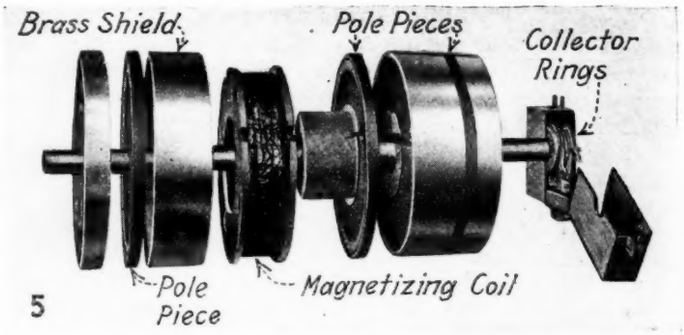
A, unloading hopper; *B*, crushed-coal elevator; *C*, raw-coal bin; *D*, rotary drier; *E*, dried-coal elevator; *F*, screw conveyor feeding dried-coal bin; *G*, dried-coal bin; *H*, pulverized-fuel bin supplying burner of rotary drier; *J*, pulverized-fuel transport pipe; *K*, drier pulverized-fuel burner; *L*, drier exhauster; *M*, cyclone collector; *N*, gas washer; *O*, magnetic separator; *P*, screw conveyor carrying fine coal from collector to bucket elevator supplying dried-coal bins.

The first operation in a pulverized-coal preparation plant, after the coal has been delivered from the cars into a track hopper, is to crush it to the proper size for feeding to the mills and to convey it to a storage bin so located that the coal will flow by gravity to the mills. The equipment required for this section of the coal handling is of a comparatively simple character and duplicates what is more or less standard with stoker-fired plants. Referring to the head-piece, which shows a rotary car dumper in operation, it may be recalled that the first two large central stations to adopt pulverized coal exclusively—Lakeside and Cahokia—were also the first to adopt this method of unloading the coal. The rotary dumper here shown, with a capacity of 20 cars an hour, is driven by a 35-hp. motor and requires but one man to operate it.

The entire operation of unloading the coal is effected



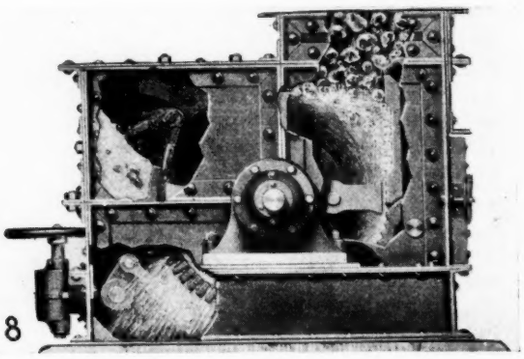
4



5

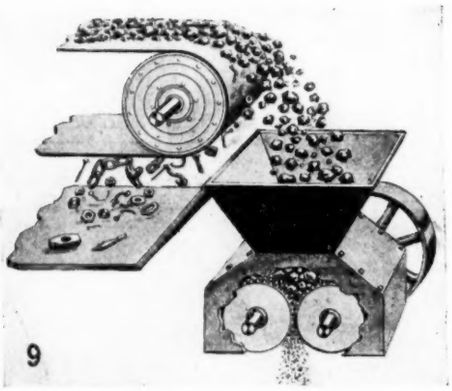
6

7



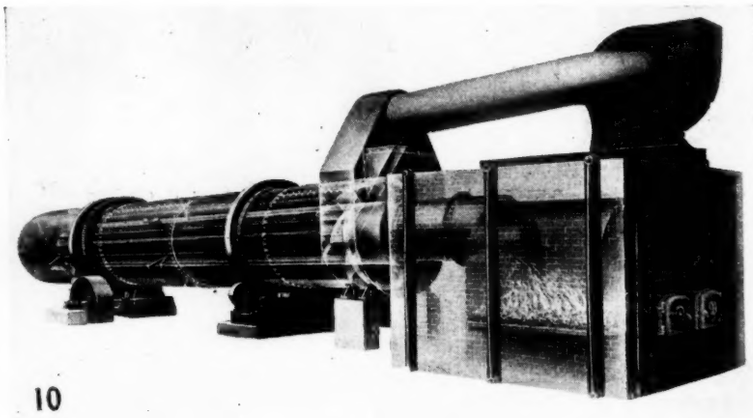
8

Fig. 4—Typical separator unit for use where belt conveyors are not installed
Fig. 5—Principal details of magnetic separator pulley
Fig. 6—Cutler-Hammer lifting-type magnetic separator
Fig. 7—Dings lifting-type magnetic separator
Fig. 8—Pennsylvania crusher with tramp-iron pocket

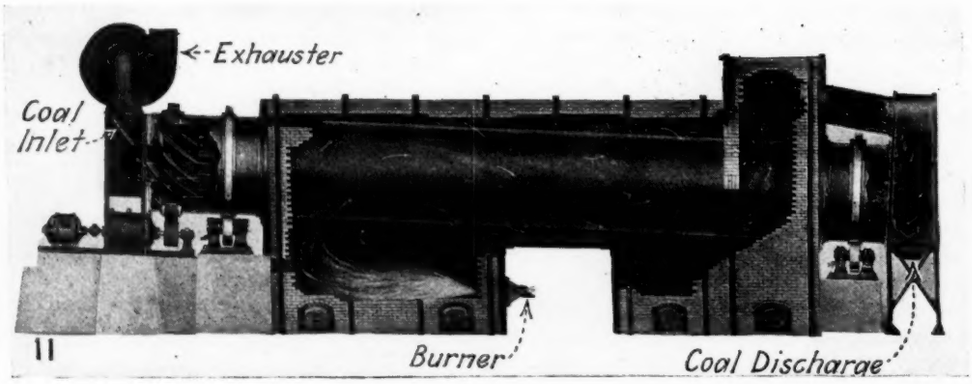


9

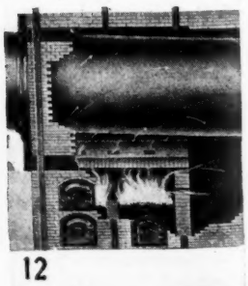
Fig. 9—How the magnetic pulley removes the tramp iron
Fig. 10—Ruggles-Coles rotary-type indirect-fired drier
Fig. 11—Fuller-Lehigh rotary drier fired with pulverized coal
Fig. 12—Drier arranged for hand firing



10



11



12

by moving the controller handle in the forward position; the clamping of the car and the amount of travel is then taken care of automatically. When the car is empty, the handle is moved to the extreme reverse position and the dumper returns to its normal position. The rotating motor is also stopped automatically on its return move-

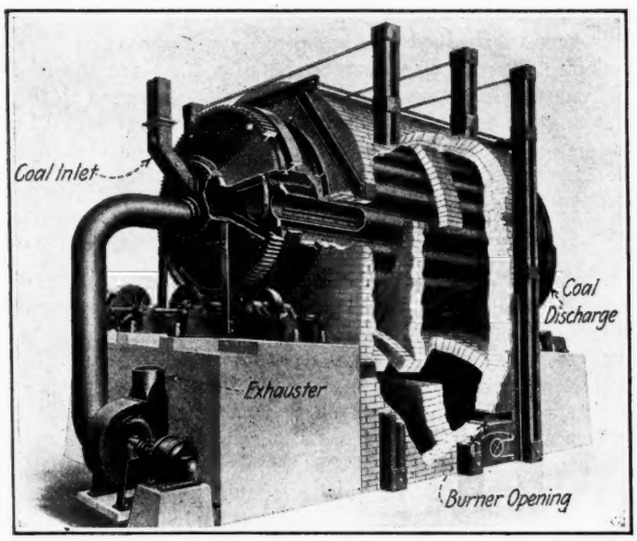


Fig. 13—Grindle multiple-tube rotary drier

ment by a limit switch, and the rails are held in correct alignment by a solenoid brake.

For crushing the coal to the required size, 1¼ in. and under, the usual single- or double-roll crusher is most frequently employed. A departure from this practice has been made in some of the larger installations by the employment of a breaker, as shown in Fig. 1, a crusher being used only to further reduce the size of the tailing. The type of breaker shown has been used extensively in byproduct coke plants and for preparing and cleaning coal at the mine mouth, but only recently has it been adopted in central stations. The details of construction and operation are clearly illustrated in Fig. 1 and need no elaboration.

In passing through the breaker the coal is reduced to 1¼ in. or under, the finer coal passing directly to a conveyor, while the tailings are carried to an auxiliary crusher as before stated.

Tramp-Iron Separator Essential

The handling and conveying of the coal from the breaker or crusher to the preparation plant or the storage bin, as the case may be, is effected by the various mechanical types of conveyors and elevators, examples of which are shown in Figs. 2 and 3. The selection of a conveyor or combination of conveyor for this purpose depends largely upon the size of the installation and the distance the coal has to be conveyed. In any case a systematic arrangement is essential in order to reduce or limit the labor factor as much as possible.

At some point in the conveying system between the crusher and the storage bins some means must be provided to remove the tramp iron in the form of bolts, rivets, railroad spikes, etc. Any one of these materials entering the pulverizer may result in damage to the machine with consequent delay in operation. This separation can be effected in several ways. Probably the most common method is the employment of a magnetic pulley at one end of a belt conveyor (see Fig. 2). The action of the pulley is shown in Fig. 9. When the coal passes over the pulley the tramp iron is attached and held firmly to it against the belt and remains in contact with the belt until withdrawn from the magnetic zone. Should it be necessary or desirable to locate the pulley at a point where there is no belt conveyor—for example, between a bucket elevator and a storage bin—a short conveyor unit as shown in Fig. 4 is usually employed.

Application of Lifting Type of Magnet

Where it is not found convenient to install a pulley in an existing installation or to employ a short belted unit, the lifting type of magnet shown in Figs. 6 and 7 can be suspended above the belt at some convenient point or at the bottom of the chute, as shown at *O* in Fig. 3. This type of separator has the disadvantage that it requires cleaning at intervals, whereas with the magnetic pulley the separation is continuous. To guard against iron being carried over the pulley with the coal or dropped back on the belt from the overhead magnet in the event of current failure, a magnetic relay is used to open the motor circuit and stop the conveyor. Direct current is required for excitation on all types of magnetic separators, and when alternating current only is available, a motor-generator set or some other type of rectifier must be provided.

Another method of separating the tramp iron and one which is entirely mechanical in its operation, has been developed and consists of providing a tramp-iron pocket in the rear of the crusher frame (see Fig. 8). The

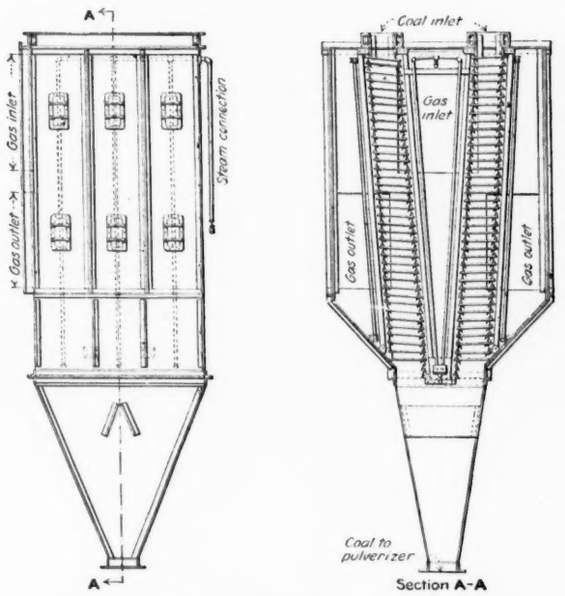


Fig. 14—Wood type of waste-heat drier

action of the rotating element of the crusher discharges the iron into this pocket from which it is dumped at intervals.

There has been much discussion the last few years as to the necessity for drying coal, and it is still a subject of controversy. Strictly speaking and from a combustion viewpoint, it is not necessary to dry the coal, but from a mechanical viewpoint drying is advisable, since the capacity of any of the several types of mills is

affected directly in proportion to the moisture content of the fuel. Some of the principal reasons for drying the coal before pulverizing may be summed up as follows: To reduce the cost of pulverizing and enable the pulverizer to operate at maximum capacity; to facilitate the handling of the coal through pipes when air transports are used; to obviate the packing and arching in the bins, thus insuring a uniform flow of fuel and uninterrupted operation; to reduce materially the chance of spontaneous combustion during storage. However, since the moisture in the coal has little or no effect on the boiler efficiency and does not materially affect the cost of pulverizing where the percentage of moisture falls below 7 per cent, it would appear that most of the Eastern coals can be pulverized and burned with good results without drying since on the average they contain less than 5 per cent moisture. On the other hand, where the percentage of moisture runs above this amount it would seem that if trouble such as cleaning the mills frequently and coal arching over the feeders is to be avoided and satisfactory and continuous operation be maintained, the moisture should be reduced to below 7 per cent.

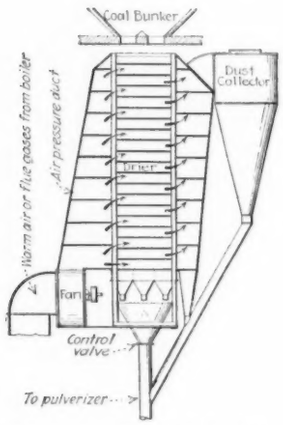


Fig. 15—Randolph type of waste-heat drier with air fan and collector

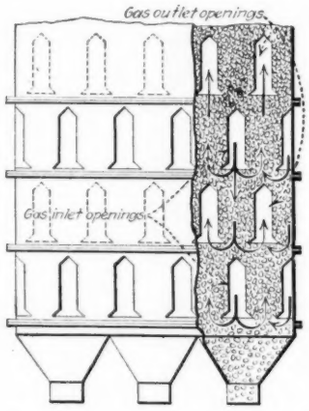


Fig. 16 — Front view of drier section, showing flow of gases through the coal

Two Methods of Drying

There are two general methods of importance used for drying coal by heat accompanied by mechanical agitation, the rotary drier and the waste-heat drier. The rotary driers may be divided into two types according to the method of applying the heat: (1) Internally heated from a furnace at one end of the drum (the firing may be direct or indirect); (2) externally and internally heated from a furnace under the drum. In the latter type the firing is indirect, as the gases from the furnace pass over the outside of the drums and then through the length of the drum, where they enter the stack chamber at the upper end of drier and escape to the atmosphere.

The drier shown in Fig. 10 is the indirect-fired type. The gases of combustion pass from the furnace through a brick-lined steel flue into the inner cylinder and then pass back in the annular space between the two cylinders, coming into intimate contact with the material being dried. The exhauster mounted on the top of the furnace is used to draw the gases through the drier.

Another drier of the indirect type is illustrated in Fig. 11. Here the shell is almost entirely inclosed in a brick housing, the furnace being located below one end of the shell as shown. The gases on leaving the furnace pass around the outside of the shell and return through the interior of the shell coming into direct contact with the coal, thence discharging to the atmosphere through the exhaust fan at the end of the drier.

In some installations the gases are discharged to a cyclone collector, as shown at *M*, Fig. 3. Here the fine coal carried in suspension is recovered and passed to the conveyor *P* and is returned to the dried-coal bin. In some cases a washer is provided for further cleaning the gases from the drier before they are discharged to the atmosphere.

Other Features of the Rotary Drier

The method of supporting and driving the drum, as well as feeding the coal is quite similar in the several makes of rotary driers, of which the ones shown in Figs. 10, 11 and 13 are typical. It will be seen that the shell is inclined. The amount of the slope varies to some extent, but is generally between $\frac{1}{2}$ and $\frac{3}{4}$ in. to the foot. Referring to Fig. 11, the coal is fed from the storage bin into the upper end of the drier shell by a reciprocating feeder which may be adjusted for any desired rate of coal flow. Lifting plates are fastened to the inside of the shell, running parallel with the axis of the drier for its entire length. The revolving of the drier causes these plates to lift the coal and drop it through the current of heated air passing through the shell. The coal is gradually advanced by gravity through the drier and is discharged at the opposite end and spouted to the boot of an elevator (see Fig. 3) which in turn delivers it to the dried-coal bins.

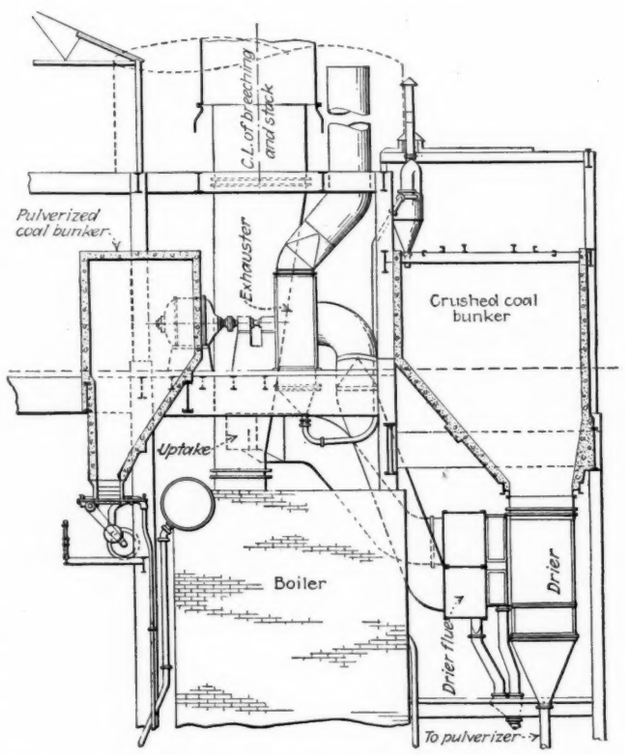


Fig. 16—Arrangement of waste-heat drier and flue-gas connections

Many other makes of driers that come under this general classification are in use, but the principal upon which the drier operates is the same. One modification is the adoption of a single pass for the gases, the inner shell extending halfway through the length of the outer drum and the final stage of the drying being effected by indirect heat from the inner drum, while the initial stage of the drying is effected by direct contact with the hot gases beyond the end of the inner drum.

In another type in which the firebox is located outside the chamber, the drum is perforated with holes 10 in. in diameter through which approximately two-thirds of the gases pass. The remainder of the gases travel along the outside of the drum and enter at the lower end. The holes in the drum are provided with angle hoods which allow the gases to enter without allowing the coal to fall out.

Multiple-Tube Drier

A departure from the usual type of rotary driers is illustrated in Fig. 13. This drier consists essentially of a number of steel tubes rotating inside of a refractory furnace. The crushed coal to be dried is fed into the tubes and as the tubes rotate, it travels by gravity to the discharge end. The heated gases from the combustion chamber first circulate around the outside of the tubes from the front to the rear and then return through the tubes, where they come in direct contact with the material being dried. The gases are drawn through the drier by the exhauster, which may be placed in any convenient location adjacent to the drier.

Figs. 11 and 12 illustrate the two general methods of firing the drier, by pulverized coal and hand firing. The former has several advantages over other methods, some of these being, more uniform furnace temperature, ease of control and decrease in attention required.

As the resulting temperature of combustion with any method of firing is much too high for drier operation, a large excess of air must be introduced to bring the temperature of a gas down to around 1,100 to 1,300 deg. F., at which temperature they enter the gas passage of the drier.

The quantity of fuel used in the rotary type of drier will vary with the calorific value of the coal burned, the initial and final moisture content of the coal to be dried, the rise in temperature of the coal in passing through the drier, the temperature of the gases leaving the drier, and the thermal efficiency of the drier.

The moisture to be removed from coal containing A per cent of moisture, to give 100 lb. of coal containing B per cent of moisture is equal to $\frac{100}{100-A}(A-B)$.

The heat used to evaporate 1 lb. of water from the coal is equal to $1{,}082 - 0.48\ T-t$, where t is the temperature of coal entering the drier and T is the temperature of the gases leaving the drier, and the heat used to dry one pound of coal is equal to the specific heat of the coal multiplied by the rise in temperature of the coal in the drier.

Waste-Heat Driers

Driers in which the flue gas from the boiler furnace is utilized for drying the coal, are of comparatively recent development. They are simple in construction, with no moving parts, and consume a small amount of power for drawing the gases through the coal. The development of this type of drier has done much toward simplifying powdered-coal installations and making feasible the housing of the pulverizing plant in the boiler-room building. Chief among the driers of this type are the Wood and the Randolph, sections of which are shown in Figs. 14 and 15.

The drier shown in Fig. 14 consists of a steel plate casing inclosing two louvered passages. The coal is admitted at the top and flows through the drier by means of gravity, being discharged at the bottom of the drier direct to the pulverizing mill. The waste gases from the boiler are admitted to the center as indicated and pass through the stream of coal to the outlet and thence through an exhauster which discharges them to the atmosphere. As a means of readily extinguishing any fire that might occur in the drier from spontaneous combustion or other causes, steam pipes are placed in the interior of the drier as shown.

The general arrangement of the Randolph drier is shown in Fig. 15, with an enlarged detail, Fig. 16, showing the flow of the gases through the coal. The drier body is built of unit sections mounted one above another, each unit having a series of gas ports as shown. Referring to the detail, Fig. 16, each alternate section has gas-inlet openings, while the intervening sections have discharge openings; the opposite side of each section is blank. The direction of the flow of the gases through the coal is clearly indicated by the arrows. It is obvious that the fan (Fig. 15) could be placed between the driers and the dust collector, so that the drier would operate under suction instead of pressure.

This type of drier can be used to advantage even in the plant having economizers. As the gas leaves the economizer around 300 deg. and the dew point of the flue gas is rarely above 100 deg. F., this leaves sufficient margin for the gases to absorb the moisture from the coal.

A typical arrangement of this type of drier is shown in Fig. 17. It will be seen that the drier is at the rear of the boilers, directly below the crushed-coal bin. The gas inlet of the drier is connected with the boiler breeching, and the gases are drawn through the drier by a motor-driven exhauster. The amount of power required ranges from 2 to 3½ kw.-hr. per ton of coal dried.

Grounding of Electric Machinery

By Warren Hilleary*

The following discussion of the grounding of electrical-equipment frames is intended to include motors, dynamos, transformers and all other equipment, whether used in connection with electric elevators or other driving or driven machinery:

The argument in favor of insulating frames is that such insulation safeguards the machines and assists in maintaining service. Not to insulate them but to ground them, is said to militate against the safety of machines and to interrupt the service. Grounding is thought to increase the stress on the insulation between the electric circuit and frame, the voltage to ground being taken entirely by the insulation of the electric circuit. With the frame insulated, the voltage to ground is shared by two layers of insulation in series,

*Superintendent Royal Indemnity Company, New York City

the layer between circuit and frame and the layer between frame and ground. Accidental grounds from failure of insulation appear to be more likely to occur in machines with grounded frames than in machines with insulated frames. With a grounded frame damage may result if there is an accidental ground or a ground connection made in the external circuit. If the frame of the machine were insulated, no damage might result.

Grounding of Frames Increases Probability of Damage

In general, the grounding of frames increases the probability of damage by accidental grounds, and the higher the voltage the greater this danger. The principal reason for this is that in low-voltage machines and their wiring the factor of safety of the insulation is high under normal operating conditions; in high-voltage machines and their wiring the factor of safety of insulation is generally less than in the lower-voltage machines.

In alternating-current apparatus the high factor of safety in the secondary or low-voltage insulation is offset to a certain extent by ground connections in the external circuit. In the primary circuits the total voltage is in many instances shared by the insulation of lines and machines in series. The insulation of the secondary circuits is less subject to damage by surges from high-frequency electrical disturbances than is the insulation of the primary circuits. However, there is great disparity between primary and secondary machines and lines as regards the factor of safety of insulation, and the insulation of primary circuits is always exposed to damage from electrical causes. Hence, with grounded frames primary machines are the most likely to be damaged.

Where an accidental ground occurs to a grounded frame, the resultant current flow to earth is the more destructive the higher the voltage of the machine. This because usually the higher the voltage the larger the kilowatt capacity and hence the greater the power for destruction. Insulating frames, therefore, appeals strongly to many as a means of safeguarding their property and service. Power-plant machinery is considered by some to be more than ordinarily susceptible to the kind of damage described.

Life Hazard Increases

With insulated frames the life hazard increases as the voltage increases. It is possible, with insulating platforms and other devices, to lessen danger from this source, and the faithful observance of their use will result in a great degree of freedom from accidents. At the same time safety here depends upon individual memory and carefulness, and in a case where the frame of a machine is in a safe condition for months, or even years, the observance of precautions in respect to it inevitably becomes lax.

It is evident that the best degree of safety lies in preventing a rise of potential between frame and ground by grounding the frame. Such grounding should be extended to machines of all voltages because there is great uncertainty as to the maximum voltage that is not dangerous to life. An exception may be made in the case of machines operating on lines supplying power at 150 volts or less, and which are not liable to contact with high-voltage lines. An exception may also be made in the case of machines where it is necessary to work on brushes when they are alive. But no exception can be made when machines of any kind operate in damp places or where there is an explosive gas or a combustible mixture of air and starch dust, flour dust, coal dust, etc. The frames here should in every case be grounded.

Factors in Favor of Grounded Frames

In support of grounded frames there are several points that may be urged, in addition to the safety secured to attendants. In the first place it is questionable whether insulating the frames decreases the stress on the insulation of the circuit to an appreciable degree. For, in order that such insulation may reduce the stress on the insulation of the circuit, it is necessary that the insulation resistance between frame and ground be comparable in magnitude with that between circuit and frame. Unless it is, the benefits derived from insulating the frame are negligible so far as voltage stress on insulation is concerned.

In fact, if the resistance of the layer of insulation between frame and ground is low in comparison with that between electric circuit and frame, the frame might as well be grounded. There are, of course, certain types of machines, such as old-type arc machines, in which the resistance of the insulation between electric circuit and frame is low, and here, insulation between frame and ground would be of assistance, but such cases are exceptional.

Insulating of Frames Conducive to Careless Operation

In the second place, insulating frames is conducive to carelessness of operation, in that the machines can be operated with an accidental ground to the frame or armature core, contrary to sound engineering practice. It enables the time of making repairs to be put off, and if the time of repairing can be put off at all, it will in many cases be postponed until something further happens, usually a second ground in the machine, which may lead to damage of a more severe character than that produced by an accidental ground to a grounded frame. With insulated frames accidental grounds are likely to develop without the knowledge of the attendants unless special means are taken to detect them. This is not often done, and incipient grounds may exist unsuspected, until a burn-out of the machine or a fatal, or at least serious accident discloses the faulty condition.

Without appreciably increasing the expense of operation, machines with grounded frames can be safeguarded to an even greater extent than would ordinarily be the case with insulated frames. For, with grounded frames, devices continuously in operation for detecting accident grounds can be used, and in addition tests can be made periodically, which will show any progressive weakening of insulation. Insulation failures can thus be detected, searched out and removed before anything serious happens. In the meantime the grounded frames guarantee safety to attendants from accidental grounds which form without warning. There is, in general, no advantage to be obtained in operating machines with insulated frames that cannot also be had with grounded frames if a reasonable degree of care is used. With grounded frames there is the additional advantage of reducing the accident and life hazard, which is one of the most important considerations.

Piping Materials, Valves and Gaskets for High Pressures and Temperatures

By JOHN D. MORGAN

SINCE the introduction of high steam pressures and superheated steam as a large factor in economic plant operation, the question of the type and kind of materials best suited for piping, valves, flanges and fittings has caused considerable investigation. However, little real scientific study has so far been made on this subject; the generally accepted conclusions appear to be as herein described.

In a few old plants there will be found complete cast-iron headers. These generally have nozzles cast on them. This type is no longer approved as good engineering practice.

The two materials that are principally used for piping are steel and wrought iron. Of steel pipe there are two classes, bessemer and open-hearth. All have been successful but show materially different qualities under different conditions.

On account of its better working properties pipe made from open-hearth steel is preferred, for it ordinarily has less carbon and a more uniform quality than bessemer. Bessemer steel may be all right in some cases, but quite often trouble occurs due to the fact that it does not run uniform. It is practically impossible to work wrought-iron pipe into a Vanstone joint, for in turning the pipe it usually splits, not only at the weld, but all around its outer circumference.

THERE is now comparatively little scientific information available regarding pipe fittings and materials for extremes of pressures and temperatures. Data are here given as derived from experience in the plant. Power would welcome further discussion of this subject.

In the threading of pipe, different working features are encountered, and in this connection it is found that with the standard threading equipment open-hearth steel is most difficult to thread properly, bessemer will thread more readily and wrought iron will give no difficulty at all.

When no accurate figures are at hand, the ultimate strengths of various pipes can be taken approximately as in Table I.

TABLE I—APPROXIMATE ULTIMATE STRENGTH OF IRON AND STEEL PIPE

Butt-welded steel pipe	40,000 lb. sq. in.
Lap-welded steel pipe	50,000 lb. sq. in.
Seamless steel pipe	60,000 lb. sq. in.
Wrought-iron pipe	28,000 lb. sq. in.

From the foregoing data we may conclude that for new work the use of open-hearth steel pipe is advisable.

For high pressures and temperatures there are several types of valves that are suitable for use; these are as follows in order of merit, in the writer's opinion: (1) The double-seated poppet type valve; (2) the globe or angle types with outside stem and yoke; (3) the solid-wedge or broken-wedge gate valve with outside yoke.

Most of the valves in general use today are of the last named type. The first two, however, are in many respects better, for unless the machine work is done thoroughly and the right quality of metal used, the gate valve will leak more freely than the other two. It is customary on all large valves to have them equipped with bypass valves to equalize the pressure on both sides, when desired.

There are many flanges in use, which vary as to actual design according to the type of joint they are intended for. Different kinds will be required for the screwed, welded, the Vanstone, ground joint with cast-iron gasket ring, and the expanded joint. The materials for flanges are cast iron, standard for 125-lb. pressure and extra-heavy for higher pressures, semi or ferro steel of standard and extra-heavy weights, cast steel of standard and extra-heavy weights, rolled steel and forged steel.

These joints all have their proper uses. The field for the screwed joint is not that of high pressures and temperatures, although, when peened, it will give fair satisfaction. The ground joint with welded flanges and a cast-iron gasket ring is a wonderful joint provided perfect workmanship is secured. As a rule, however, it is quite difficult to obtain this workmanship.

There is no question, from a manufacturing viewpoint, that the welded joint is superior, but in the field of erection, its great rigidity is the principal drawback. If the Vanstone joint is made with care, with the high hub and with improved reinforced square corner having raised faces from the inside of the bolt circle to the inside of the axis of the pipe, there can be no question as to the superiority of this type. There has been developed a joint where the pipe is rolled into recesses in the flange. This is quite satisfactory, but has not been generally adopted so far.

There are many kinds of gaskets that are suitable for superheated steam. The type in most general use appears to be the soft Swedish corrugated steel gasket, applied with a cementing compound. Also, there are a number of other good makes; for instance, the asbestos gasket, shrouded with copper or bronze, and the compressed asbestos sheets. The corrugated copper gasket is quite common, however.

The important point in this gasket is that under certain conditions pitting occurs. With gaskets in general, their proper installation is most important. This is accomplished only when the bolts are drawn up tight and uniformly over the complete bolt circle.

The fittings more generally encountered are tees, ells, Y's, crosses and laterals. These are of cast iron, semi-

steel and cast steel, and are of standard and extra-heavy weights.

In the latest and most modern plants it has become standard practice to eliminate fittings wherever possible. This is accomplished by the use of welded nozzles on the pipes. These nozzles can be of any length or size and with any type of joint.

By means of electric or acetylene welding, it is possible to obtain a substantial weld for any pressure. By this method it is possible to lighten up on the total weight of the piping and to eliminate from 50 to 65 per cent of the total joints.

For high pressures and temperatures there are two types of expansion joints that are suitable, namely, the slip type, with a properly packed joint, and pipe bends. The corrugated reinforced copper expansion is not suitable for superheated steam.

Relative Elasticity of Pipe Bends

Of the pipe bends, there are several: Quarter-bend, U-bend, combination U- and quarter-bends, expansion U-bend and the double-offset expansion bend. Assuming 1 as the proper expansion movement that the quarter-bend will accommodate, then the relative expansion values for the other bends are as follows: U-bend, 2; combination U- and quarter-bend, 4; and the double-offset expansion bend, 5.

The design of the bend, the radius, and the weight of the pipes must all be correctly proportioned in order that the proper amount of expansion and contraction may be compensated for without damage to the piping or bend.

Recently, the A.S.M.E. Boiler Code was revised as to specifications in relation to cast iron and superheated steam: "Cast iron shall not be used for nozzles or flanges directly attached to the boiler at any pressure or temperature. Cast iron shall not be used for boiler or superheater mountings such as connecting pipe, fittings, valves and their bonnets for steam temperatures over 450 deg. F." No mention is made in the Code for the piping systems at large.

At a more recent date the United Steamboat Inspection Service authorized the use of semi-steel gray-iron mixture for superheated headers on ships, and Lloyds have also adopted this ruling. This shows a diversity of opinion. These various rulings have caused considerable discussion. It is the general opinion among well-known engineers of today that a good deal of the trouble experienced with extra-heavy cast-iron fittings and valves when operated at temperatures not exceeding 500 deg. F., has been largely due to the design rather than to the character of the material.

Abroad, the use of cast iron of a grade we call gun iron has given good success, although it is generally conceded that for high steam pressures and for temperatures in excess of 500 deg. F. steel fittings should be used. It is a well-known fact that cast iron, when subjected to temperatures in excess of 500 deg. F., does in some cases show a permanent increase in some dimensions. How long this growth would continue is uncertain. That the strength of cast iron is materially reduced when exposed to temperatures not exceeding 550 deg. F. has not been conclusively proved, and as a matter of fact, some engineers claim that the strength of cast iron increases till it reaches the break-down point around 800 deg.

The growth of cast iron depends on its chemical composition. For instance, the presence of phosphorus tends to diminish this, and as a general rule it can be said that 0.1 per cent will cause a decrease in growth of 1 per cent. Sulphur is rarely present in sufficient quantity to have more than a small influence upon the growth, but its general tendency is toward retardation.

The presence of manganese retards the rate of growth. The most important constituent of cast iron with regard to this property is that of silicon. The increase of silicon in the cast iron promotes growth. For instance, with the presence of 1 per cent of silicon, the increase in growth will be about 15 per cent, while if 3 per cent is present, this will be 37 per cent.

It seems most probable that most of the failures of cast-iron fittings in stationary power plants where the temperature does not exceed 550 deg. F. has been due to the following factors: (1) The poor quality of the cast iron; (2) the variable temperature of the steam; (3) the poor design of the fittings and flanges; (4) the lack of sufficient expansion joints.

Cast Iron Successful at 700 Deg. F.

These facts are borne out in the locomotive field. There are over 37,000 locomotives in this country and 25,000 in foreign countries that have cast-iron superheater headers and steam pipes, operating every day with temperatures from 600 to 750 deg. F. They are subjected to greater strains and more sudden temperature changes or fluctuations than any stationary power plant. Failures of these headers and steam pipes are practically unknown as caused by high temperatures.

Semi or ferro steel has not been given a real try-out. One manufacturer's catalog states that ferro steel is but a cast iron with usually a somewhat lower carbon content. At times when it is economically preferable to make ferro steel by properly proportioning the charges, of pig iron and cast-iron scrap, it does not contain one pound of steel of any kind. In other words, the foregoing means that what they have been selling in the past under the name of ferro steel according to their own confession is nothing but a good grade of cast iron.

It would seem from all reliable information that the use of a high grade of cast iron or semi-steel, for fittings, is permissible for temperatures about 500 deg. F. and that steel fittings are advisable for higher temperatures. However, many advocate the use of steel fittings in all cases because a greater factor of safety is afforded. But the fact remains that the use of cast-iron and semi-steel fittings for a certain limited temperature is by no means poor engineering practice.

Nickel in High-Temperature Valves

The material best suited for valve seats, disks and bushings is that of nickel or monel metal. These metals have practically the same expansion and contraction as steel.

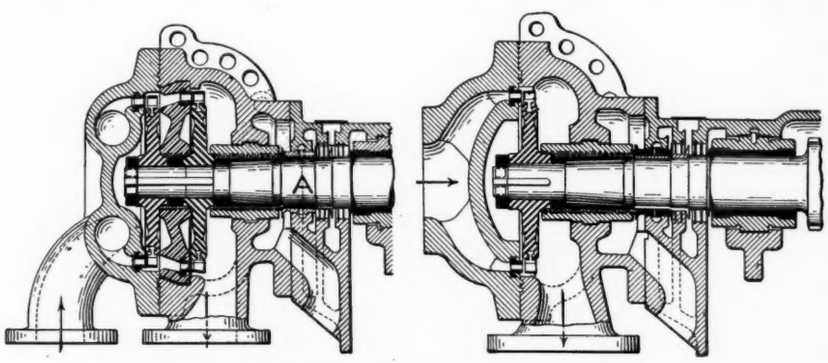
Brass or bronze is unsuitable for use with superheated steam or high temperatures. At temperatures approximately 650 deg. F. the breaking strength of bronze ordinarily used is only about 12,150 lb. per sq.in. Its elongation at this temperature is only about 1½ per cent. This is quite a serious breakdown in physical properties, for at normal temperatures its elongation is about 37 per cent and it has a breaking strength of 34,000 lb. With regard to the metal for the body of the valve, the same conditions apply as those for fittings.

High-Pressure Turbine with One Packing Gland

As pressures are increased, the difficulty of providing suitable shaft packing for steam turbines increases. High-pressure units receiving steam in the neighborhood of 1,000 lb. and exhausting at 500 lb. and upward, are being built with an overhung cylinder by Brown, Boveri & Co., of Baden, Switzerland, as described by *Power's* correspondent, Bruno Shapiro. Turbine elements of this kind, shown in the figure, are designed for high speeds, and to be operated with reduction gears. The turbine wheels are mounted directly on the pinion shafts, and the turbine casings are supported from the reduction gear frames. A number of such turbine elements may be utilized in one reduction gear in accordance with the number of pinions employed.

Admission pressures of 1,140 to 1,400 lb. are characteristic of turbines as shown in the figure. These operate at 8,000 r.p.m. The turbine at the right is the first section of a 10,000-kw. unit, in which the initial pressure is 900 to 1,000 lb. and the output of the wheel 2,000 to 2,200 kw. This exhausts into one that is a duplicate of the first. Two medium-pressure cylinders, each containing two wheels, are of the type indicated at the left of the figure.

High speed and small diameters for the wheels make it possible to obtain small turbine casings, with full steam admission and longest possible blades. Low circumferential speed keeps down the stresses on both wheels and blades produced by centrifugal force. This is necessary on account of the high temperatures at which the turbine operates.



Turbines for 1,400 lb. steam mounted on pinion shaft

With the overhanging position of the turbine only one stuffing box is required, and this is subject to the high pressure of the exhaust. The main packing in this case consists of a large gland of labyrinth construction. An interesting feature in connection with this packing gland is a second or auxiliary bushing supplied with water for the purpose of keeping the shaft cool. This bushing is indicated at *A* in the left of the figure, being placed between the main packing box and the bearings. Water is piped to a groove in the middle of the bushing. The escaping fluid is heated by steam leaking through the main packing box. Heat thus discharged is returned to the boiler feed.

In the overhung type of turbine a thrust is exerted against the shaft by the steam pressure. This axial thrust is equal to the area of the shaft where it passes through the exhaust end of the casing times the gage steam pressure acting on the shaft. With high exhaust pressures of this kind the thrust is considerable. In this case it is partly or wholly taken care of by the teeth of the gear. These are designed at an angle suitable to thrust conditions. A thrust bearing may be supplied in addition if desired.

Materials for turbines, operating under high pressure and temperature conditions, are important. Here the casings are made of steel castings, particularly electrical steel. Stuffing boxes consist of chromium-nickel steel or other first-rate non-rusting steel, while the softer parts are made of Monel metal. The blading and wheels are of first-rate heat resisting steel. Pinions and shafts are of chromium-nickel steel. The pipe connections in general are made of a number of thin steel tubes rather than of one large pipe. This permits greater flexibility and prevents, to a large extent, the thrust that would be exerted by larger pipes under these conditions of temperature.

Insulating and Cooling Large Transformers

Pressboard, wood, cotton and oil were the major insulating materials known and extensively used by transformer manufacturers ten years ago. Wood has since been discarded as a major insulator. Every modern transformer still contains wooden structures, but these serve only as a means to support major and much more reliable insulators, such as porcelain bushings. Pressboard is now used only as a minor insulator, and cotton is being gradually superseded by oil paper. A large number of new solid insulating materials are coming into extensive use for high-voltage machines, such as cylinders and flat pieces of compounds of the bakelite type.

The excellent dielectric qualities of good transformer oil remain so only as long as the original chemical conditions of the oil are maintained. Oxygen and moisture in air are two arch enemies of hot oil, and their combined attacks upon it may, within a short time, reduce its high dielectric strength to a fraction of its original value. The life of a modern high-voltage transformer depends greatly upon the condition of its oil. The simplest way to maintain the oil of a transformer at its best is the exclusion of oxygen and moisture, both of which can be achieved with an oil conservator. The actual operating experiences with conservators obtained in the field on machines during the last eight years, has resulted in their extensive use today for all high-voltage or large-capacity transformers.

A large power transformer operates with an efficiency of about 99 per cent or a loss of about 1 per cent. The missing one per cent, or the loss due to transformation, manifests itself in the form of heat. This loss is only one per cent or less, but on a large machine it represents quite a bulk of power. Assume a 20,000-kva. transformer, running at full load with 99 per cent efficiency. This means that 200 kva. is being used constantly to supply, so to speak, an electric oven, the heat of which has to be disposed of. Two hundred kilowatts of heat energy is no small amount. An idea of its magnitude may be obtained from the fact that it would be enough

heat to keep thirty average living rooms comfortably warm in zero weather!

The liberated heat has to be caught at its source, which means free access of the heat carrier, oil, to every part of the winding and the iron core. Modern windings accomplish this in a way hardly capable of improvement. So far has the subdivision of the windings been carried that, with disk coil and helical windings, every individual turn of the copper conductors is exposed to the oil at two of its edges. One or more internal ducts through the iron core and its yokes permit access of the oil not only to the surface, but also to the innermost parts where heating is most likely to occur. The oil, being only the carrier of the heat, has to give up its heat in turn to some cooling medium. The tank itself may be used for this purpose or it may be used in connection with some artificially increased surface such as external tubes or radiators, with no limit of capacity. Such self-cooled units have been built for as high as 15,000-kva. output.

If the self-maintained character of a self-cooled transformer is not sufficiently valued to warrant the larger floor space required and the cost of the radiators, and if clean and cheap water is available under pressure, water cooling is chosen, when the water-cooling coil is either within the main tank or at some convenient external place. In the latter case a motor-operated centrifugal pump is used to keep the oil in constant circulation. This cooling method permits the design of a transformer with physically smallest possible dimensions.

An Engine-Vibration Problem

In the majority of manufacturing plants vibration from moving machinery is considered a necessary evil. In fact, operating engineers are so accustomed to vibration and noise in their plants that any change in this condition is quickly apparent, and often they are able to head off trouble before it gets to a serious stage. As a general rule the vibration does not affect adjoining property, but one manufacturing company had an engine belted to a generator that set up vibration in two- and three-story brick and frame residences 400 to 800 ft. away, of such a serious character that the property owners got out an injunction to have the unit shut down.

The engine is of the poppet-valve type, 21x21-in., running at 175 r.p.m., taking steam at 105 lb. and exhausting against 2 lb. back pressure. It is belted to a 175-kw. direct-current generator running at 500 r.p.m. The concrete foundation for the engine is of ample size and, as recommended by the engine manufacturers, a separate foundation had been provided for the generator. The soil is of sand and silt formation and the water level a little above the bottom of the engine foundation. No piling or spread footing had been used.

Several suggestions on how to overcome the vibration had been made, but all required the shutting down of the engine for some time and expensive alterations. The engine was gone over carefully for alignment, all bearings pulled up as tightly as practical, and various settings made of the steam valves, but there was no noticeable change in the vibration.

The engine had been set so that the piston moved north and south, and in testing the vibration with a glass full of water in various places, the water would be spilled over the north and south sides of the glass only. When sitting in a chair on the second and third floors of the residences, a person's head would start nodding, but only in a north and south direction. Weighted pendants hanging from chandeliers would swing north and south.

From the investigations made it was decided that the engine and foundation set up a harmonic motion that was transmitted through the water-filled soil, and the buildings responded in a certain degree to this particular wave length.

To test out this theory, it was decided to try out the effect of changing the speed of the engine. After the factory load was off on Saturday, the engine was run on the throttle at lowered speeds and the vibration finally stopped. Then the engine governor was adjusted for lower speeds and each time the revolutions per minute determined. The original speed of the engine was 175 r.p.m. The first drop was to 166 r.p.m., a decrease of 9 revolutions. At this speed the vibration in the residences would die down to where it was barely perceptible, but would build up gradually to the same intensity as at 175 r.p.m., then gradually decrease and so on. The speed was reduced gradually until at 150 r.p.m. there was no appreciable vibration in any of the buildings.

The electrical load on this engine approximated 75 kw., and as there was no immediate prospects of any great increase and plans were under way to remove the unit eventually, a different pulley was installed on the generator so that it would run at normal speed and the engine adjusted for 150 r.p.m. This did away with all complaints from adjoining property owners and still allowed the generating unit to carry all the load that was required of it.

Acknowledgement is made to the Columbia Industrial Machinery Co., of Chicago, which conducted the investigation and is responsible for the ingenious method of solving the problem.

That the world's market for internal-combustion engines is not in a state of stagnation is indicated by the report of the exports by German engine builders for 1923. While the report is on the basis of shipping weight and not horsepower, the latter may be fairly approximated by assuming that an engine weighs 220 lb. per horsepower, although this will be too low for Diesels and too high for gasoline engines. On this basis, Argentine received from Germany 24,274, Brazil, 6,636, and Mexico 12,506 horsepower. In other words, these three countries purchased from German builders engines equal to one-half of those exported by American builders to the entire world.

In a test on 1,000-hp. gas engines, as reported in *The Power Engineer*, London, Eng., the following figures for the exhaust heat recovered were obtained:

Duration of test, hours	3
Horsepower output of engines	1,661
Temperature exhaust, deg. F.	698
Temperature leaving boiler, deg. F.	378
Temperature leaving economizer	323
Steam pressure, lb. gage	88
Evaporation, lb. steam per b.hp.-hr., from and at 212 deg.	1.78

This exhaust temperature is about that found in Diesel practice, so that these values may be taken as approximately the results to be expected from a boiler in conjunction with a Diesel engine.

Routine and Emergency Operating

OPERATION in its broad sense includes the handling or manipulating of machinery, as well as its care and maintenance. While there are undoubtedly at times troubles which occur that could be classed purely as accidents, ordinarily there are few such occurrences that would be considered unavoidable. Difficulties that thus arise may be dealt with as a part of the general routine or may be of such a character as to require extreme measures, as a shutdown due to floods, machine failure, lightning, etc. There are thus two kinds of operating work which differ greatly and which might be classed as routine and emergency operating.

In emergency situations the main object ordinarily, is, to restore normal operating conditions as quickly as possible. Expense is generally subordinated; apparatus and supplies should be abundantly forthcoming, with the personal interest of the higher executives leaving nothing unturned to secure supervision of the highest order. From practically all sides conditions favor a successful outcome.

In spite of the limelight that surrounds such activities, the ordinary routine work, of which little is heard, appears to be vastly more important. Generally speaking, circumstances are reversed in the latter case, as economy, on which profitable operation largely depends, is an ever-present factor. Supplies, apparatus and the personnel of the force are all restricted to economic standards. While an immense volume of work must be carried out, the consequences of carelessness or a mistake are none the less present. There is the advantage that nearly the same line of effort is followed repeatedly so that cumulative experience may guide and standardize it to a large extent. The major responsibility, however, for success must always rest in following the routine of the regular operations, careful checking of such work, planning of the future and, most important of all, taking measures in time to prevent what might otherwise develop later into emergency situations.

A Waste Worthy of Consideration

WHEN the heating of buildings is considered, the production of heat and transmitting it to the various parts of the building are the factors that generally receive first attention. Keeping the heat in the building is something, although of equal importance with the other two factors from a fuel-saving point of view, that frequently receives scant consideration. Much has been done to improve heating systems and methods of burning fuel, but the standards of construction in many classes of buildings have at the same time deteriorated. It seems like useless effort to try to improve the heating process at one end while at the other waste is on the increase. Nevertheless, this is just what has been happening, while the public pays the bills in high rents and increased heating costs.

According to a survey completed in Chicago by the Bureau of Industrial Research, which extended into all parts of the country, thirty and probably fifty per cent more fuel is consumed for heating the homes in the northern sections of this country than would be necessary if proper standards of construction and materials were maintained. The cost of this poor construction is placed at nearly half a billion dollars annually for fuel burned, the heat of which is wasted through the walls and roofs of buildings. In addition to this the unnecessary burning of valuable fuels is an economic waste.

This report would indicate that there has been a great laxity in conserving heat after it is produced. Anything that can be done in a heating or power plant that will result in a saving equivalent to paying a reasonable dividend on the investment necessary for the equipment to improve the efficiency of the plant, is generally considered a good business proposition. Is it not about time this same attitude was taken toward conserving the heat in buildings by giving a little more attention to their construction? The suggestion by the Bureau of Industrial Research that all buildings be given a fuel-cost rating for the benefit of purchasers and to encourage more permanent construction, has much to recommend its serious consideration.

Power Supply for Power-House Auxiliaries

DURING the period since the introduction of electric power generation and distribution, there has been a gradual electrification of industry. Similarly, in the larger power stations the auxiliaries are being electrically driven. In the earlier plants they were driven by steam turbines and reciprocating engines, which is still the practice with some of the more important auxiliaries in the modern plants, or emergency steam-driven auxiliary units are provided. However, the tendency is more and more toward electrically driven auxiliaries, particularly where an emergency power supply can be provided for the motors.

Certain operating difficulties that have recently developed in some of the large stations may have an effect to change this tendency but this is something that only the future can reveal.

Maximum economy in the modern large station demands one hundred per cent electrically driven auxiliaries and stage bleeding of the main turbine for feedwater heating. On the other hand, the requirements involved in supplying electric power from large stations demands the utmost in reliability. To co-ordinate these two requirements power-plant designing engineers are giving a vast amount of attention. There are three sources within the station that may be used to supply

power to auxiliaries—main busbars, house turbo-generators, and house generators coupled to the main generator. Although the main generator can be considered one of the most reliable pieces of equipment in the station, it is connected to a transmission and distribution system that may seriously affect the reliability of the main busbars as a source of supply for the auxiliary drives. For this reason operating men have hesitated to depend upon this entirely as a supply for the auxiliaries. Although the house turbine is a distinct advance in heat-balance control and provides a second source of electric power for driving the auxiliaries, its use results in a lower station efficiency than when all the load is supplied from the main units.

Recently, considerable attention has been centered on the use of an auxiliary generator coupled to the shaft of the main generator as a separate electrical system for driving the auxiliaries. When this system was first suggested, it was felt that extending the length of the main generation unit might interfere with the alignment and balance of the machine; also that increasing the length of the main unit would necessitate increasing the width of the generator room, resulting in an increased construction cost.

These objections have little to sustain them, since a flexible coupling between the two generators practically makes the alignment of one unit independent of the other and the auxiliary generator occupies only part of the space that must be provided for removing the rotor from the main generator. Where auxiliary power is supplied from the main generators, it must be stepped down to the voltage of the motors. When an auxiliary generator is used, it can be designed for the motor voltage, therefore transformers do not have to be used and the machine will have about the same efficiency as the main generator and transformer. In addition to this the auxiliary generator may be made either direct or alternating current, depending upon the kind of motors used. The real test of any piece of equipment is how it meets service conditions. Although the auxiliary generator has not had long enough existence to prove its worth by the test of time, considered from the theoretical angle it appears that those under construction will be able to make good on the designer's claim.

Taking the Guess Out of Heat Transfer

WITHOUT at all minimizing the technical difficulties of electrical design, it may be said without fear of contradiction by scientific men, that we know much more about electricity than we do about heat, and in particular about heat transfer. The word "know" is here used in its scientific sense, denoting ability to predict what will happen under any given combination of circumstances. One of the reasons why less is known about heat transfer than about electricity is that the subject is more difficult. The flow of a direct current through a conductor may be satisfactorily predicted by Ohm's law, an extremely simple equation. The laws for the force produced by a conductor carrying a current in a magnetic field, and for the voltage generated when a conductor cuts lines of magnetic force, are equally exact and almost as simple. Only mechanics can rank with electricity in the simplicity and accuracy of its known laws. Close agreement between theory and practice is the test. The electrical designer, grounded in the every-day fundamentals of his profession, can lay out an entirely new design on paper with reasonable assurance that the finished apparatus will function about as he predicts.

With heat—and in particular with heat transfer—the situation is quite different. In this field design is still to a great extent a "cut and try" process. While performance may be predicted with fair reliability where tests have been made on similar apparatus of similar size, the designer is likely to find a wide variation between predicted and test results if he attempts radical deviations from standard practice. The laws of heat transfer have never been properly formulated. The simpler cases of conduction are, it is true, subject to simple and well-known laws, but conduction never occurs as an isolated problem. All practical problems of heat transfer involve radiation and convection as well. Convection, in particular, is the most important item involved in the transfer of heat between solids and fluids. It is also the least understood. The design of boilers, heaters, etc., can never be placed on a rational basis until our knowledge of convection is greatly increased. The problem is extremely difficult, involving seven or eight variables.

In view of the difficulty and importance of this subject of heat transfer it is encouraging to note that engineers are no longer satisfied with the rules of thumb and "test data" that prevail in this field. They want something more fundamental, something that will apply everywhere that a heat-transfer problem occurs. They are about ready to pool their interests to finance a comprehensive program of scientific research on the subject. This will cost a lot but will be worth every penny.

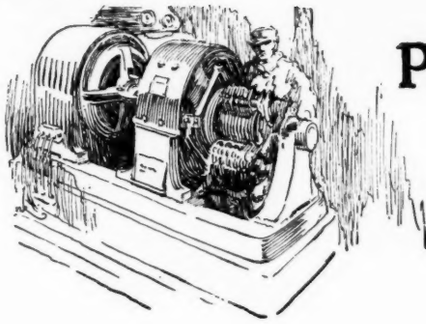
Sandblasting in the Power Plant

SANDBLASTING has long been employed in metal-working establishments where, before lacquering, the object must be cleaned of all surface scale. Recently, a few bold spirits have made use of the sand-blast in power-plant work.

In the St. Louis Pumping Station, where steam turbines are used to drive centrifugal pumps, it was found that the efficiency of the units had fallen off twenty-five per cent from the guarantee figures. Investigation revealed that the first five rows of turbine blading were almost completely closed with sediment. After replacement of a few rows the entire blading surface was given a sandblasting. As reported by Leonard A. Day before the Annual Convention of the American Water Works Association, this blasting removed all the scale and upon resumption of service the original steam-consumption guarantees were equaled.

A second application of sandblasting is in the cleaning of boiler tubes. While other methods, such as the wire brush, removes much of the soot, the surface scale remains to lower the heat transfer. Sandblasting will remove all deposits down to the bare tube and may be used both on fire and water tubes.

It is now possible to determine the efficiency of waterwheels at reasonable cost, so that it is no longer necessary to operate these plants by guess as has frequently been the practice in the past. Experience has shown that maintaining high efficiency in water-power plants may pay as well as in steam stations.



Practical Ideas *from* Practical Men

What the Indicator Diagrams Show

Indicator diagrams will record and show us many things regarding the setting of valves and the conditions under which the steam in the cylinder is working, yet there are other things about an engine that an indicator will detect but the eye will not. The accompanying diagrams may be interesting to engineers inasmuch as they corroborate the foregoing statement.

The diagrams were taken from a marine triple-expansion engine having cylinders 17, 25 and 43 in. in diameter with a 30-in. stroke.

The engine was fitted with piston valves on the high and intermediate cylinders taking steam in the center, while the low-pressure has a double-ported slide valve, and the engine cranks spaced 120 deg. apart.

The diagrams were taken from the intermediate cylinder, using a telescope reducing motion. The diagram Fig. 1 was recorded in the usual way.

After taking a few diagrams, I detected a noise about the engine and, in investigating the cause, happened to place one hand on the stud on the frame end of the reducing motion and the other on the reach rod of the low-pressure link valve gear and noticed that the motion

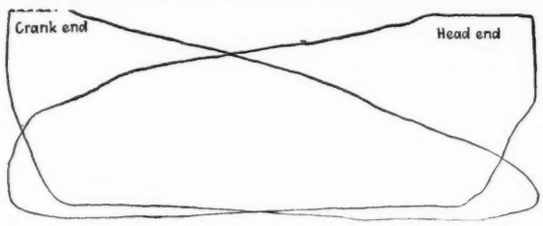


Fig. 1—Diagram obtained from intermediate cylinder of the triple-expansion engine

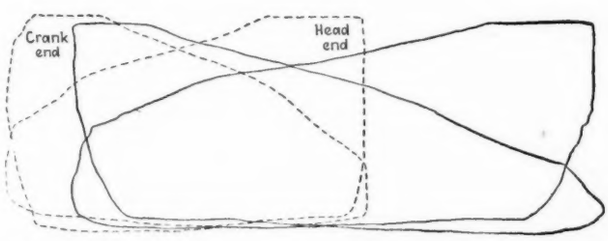


Fig. 2—Diagram from link motion (dotted) taken on same card as regular diagram

imparted by each was in synchronism. As the noise was nothing serious, my thoughts were directed to the discovery just made, so after considering the two engines set 120 deg. apart, one operated by a piston valve taking steam in the center and the other operated by a slide valve, I decided to take a diagram with the drum motion connected to one reach rod of the low-pressure valve gear. The diagram that was thus obtained is shown in Fig. 2.

It will be noticed that the diagram taken from the link gear is shorter owing to the impossibility of connecting the cord near enough to the valve stem, as the cord interfered with the bottom of the cylinder casting. It will be noticed that the steam lines on both diagrams

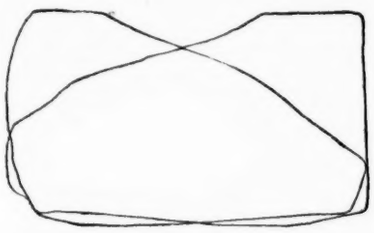


Fig. 3—Diagram obtained with reducing motion connected to the link valve gear

are approximately the same length, while the balance of the diagram is shorter, yet the lines are similar except the compression and admission lines, this difference being due to the fact that the low-pressure valve gear is not in strict synchronism with the piston of the intermediate engine, but leads the piston on the up stroke and lags on the down stroke. While the indicator proved that the two motions were not exactly the same, it did prove that the eye does not always detect the relationship of one part of one engine to that of another, as I had often watched this engine but always with regard to each engine as a unit. Fig. 3 shows a diagram taken from the link motion of the low-pressure valve gear, which is of the Stephenson type.

New London, Conn. ROBERT H. LARKIN.

Putting the Right Man on the Job Greatly Reduces the Repair Cost

Being a consistent believer in the doctrine of the conservation of waste, whether of materials or labor, I was much impressed by a conversation I overheard some time ago, and since the experience related is undoubtedly common in many plants, it may be of interest to other readers.

In a certain plant several castings of considerable size had been broken and there were no new ones to take their place. Welding was out of the question, so strips of steel had to be bolted on. The repair to the first casting was made by three repairmen, who in most plants would be classed as handy men, the hourly wage of the three amounting to $1.64. The repair was finished by them in eight hours at a cost for labor only of $13.12. Owing to a rush of work, when the rest of

these castings were to be repaired, they were turned over to the machinist, with the following result:

The machinist was a trained mechanic of many years' experience, and he proceeded to do the job in a more practical way, laying out the work and letting his helper do the drilling. The repair on each casting was completed in three hours at a total cost for labor only of $2.20. This charge was made up as follows:

One hour's time of machinist laying out and assembling, 85 cents; three hours' time of helper, at 45 cents an hour, $1.35.

Now, if this machinist were a salesman for some concern, he would participate in the profits of his employer; but since he is a mechanic, no matter how much he reduces maintenance costs by the exercise of his skill or the ingenuity of his brain, he receives no return other than his hourly wage. This is one of the reasons why it is getting to be more and more difficult to obtain men for the machinist trade.

When employers adopt some method whereby a mechanic gets a suitable return when he cuts the cost of such work, to the benefit of his employer, we will again have plenty of men of mechanical ability to take up the machinist trade.

W. E. WILKINS.

New York City.

Gets White Ice

I am working in a raw-water ice plant and we are having more or less trouble with our ice. In one tank, holding 336 cans of the 300-lb. size the agitating air

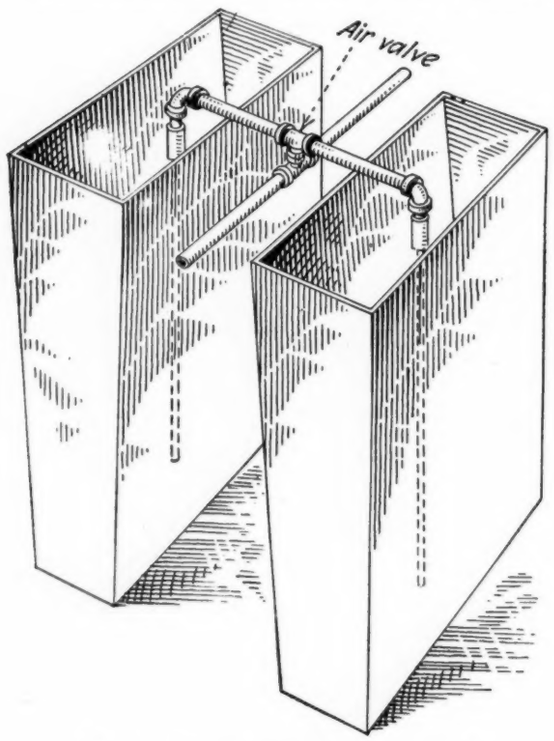


Fig. 1—Arrangement giving clear ice

drop tubes are arranged as shown in Fig. 1, one valve controlling air for two cans. This batch of cans gives clear ice. In the second tank 208 cans of the same size are arranged as shown in Fig. 2. Here each can has a separate valve and will produce only white or milky ice. The air pressure is furnished by a low-pressure blower at 5 lb. gage. The air goes into a cooler whose safety valve is set for 10 lb. gage, but as the cooler tubes leak the water has been shut off. Both tanks get air from the blower, which is placed as nearly

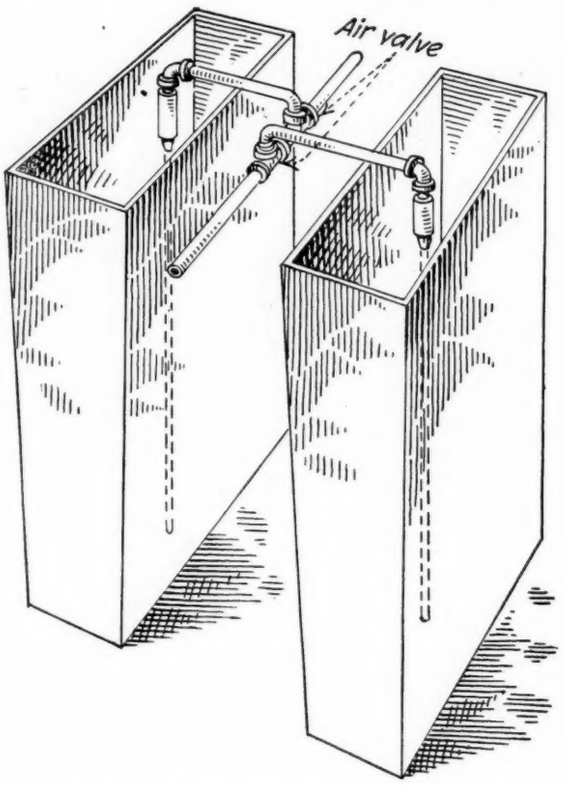


Fig. 2—These cans produce cloudy ice

midway between the two tanks as circumstances will allow.

I would appreciate it if some of the readers of *Power* could tell me what to do or what not to do.

Geneva, N. Y. R. G. SUMMERS.

Notes on Making Screwed Pipe Joints

Not infrequently, in factories and other plants unskilled workmen are called upon to do a bit of pipe fitting, and sometimes much difficulty is encountered in making tight joints. The following practical experience may be of interest:

A few days ago in our plant one of the workmen connected a pipe to a tank with a working pressure of 6,000 lb. (hydraulic). The pipe joint leaked badly, so he was instructed to disconnect the joint, cut off half the length of the threads and replace the pipe. On doing so he was astonished at the joint being made perfectly tight.

To make a good joint the threads on a pipe should not be too long or they will be too small in diameter to make a tight job. After threading the pipe, it should be possible to screw the fitting on by hand only about two threads, after which it should be finally tightened with the pipe wrench. To make a lasting joint for high-pressure steam, hemp should not be used, as the heat will soon burn it away and cause the joint to leak. Metallic packing, red-lead paint or asbestos string or other good jointing compound is preferable.

Manchester, England. E. ANDREWS.

Comments from Readers

Trouble from Babbitting of Main Bearing

Referring to the inquiry of W. L. D. in the April 22 issue as to how he can prevent the babbitt breaking in the main engine bearing, the reply advised him to use a mixture of 3 parts copper, 89 parts tin and 8 parts antimony. That is a good babbitt formula provided, of course, it is properly alloyed. If it is just "mixed," it is liable to crush out. Besides, there is danger of hard-points forming in the babbitt. A hard-point is a combination of copper and antimony and is found in babbitts improperly alloyed. A single hard-point reaching the surface of the bushing, will invariably damage the shaft.

It is also stated in the reply that inferior grades of anti-friction metal are principally composed of lead and wear rapidly. This is also true to the extent of service in a main engine bearing. Lead-base metals lack the tough body so necessary to absorb the shock that a main engine bearing gets. But the reason a babbitt breaks up in such a bearing is frequently impurities in the tin used. Arsenic is an impurity found in some grades of tin. A fractional percentage of arsenic in a babbitt will often be the reason for a crushed babbitt lining.

There are other reasons for a babbitt breaking up, but space will not permit going deeply into this subject. In my opinion the best advice to an engineer who is troubled with his babbitt breaking up is to have him put it up to a reputable manufacturer of babbitt, sending him a piece of the broken lining for analysis. He will then profit by the experience of the manufacturer and will not have to experiment with formulas when the trouble may be entirely outside the province of the babbitt.

A. HOYT LEVY.

Brooklyn, N. Y.

Low-Temperature Feed Heating by House-Turbine Exhaust

It is stated in an article in the May 13 issue that at the new Hudson Avenue station of the Brooklyn Edison Co. the first stage of heating is accomplsihed by steam exhausted from the house generator at about 25 in. vacuum. It is explained that if the house turbine could use steam as effectively as the main turbine, it would make no difference whether the first stage of feed-water heating were accomplished by the house-turbine exhaust at 25 in. vacuum or by steam bled from the main unit at the same pressure.

If the saving due to the reduction of moisture in the last stages of the main turbine that is claimed from the bleeding of steam is neglected, it must be admitted that the only loss resulting from the use of the house-turbine exhaust instead of bled steam is that due to the lower efficiency ratio of the house turbine. The writer wonders why it would not have been better to have used the house-turbine exhaust for the second-stage heating rather than the first, as this would have resulted in the generation of a smaller amount of power in a lower-efficiency turbine during normal operation, but would give as great a capacity as the present arrangement during station interruptions when no condensate would be flowing through the heaters and the house turbo-generator would have to exhaust to atmosphere.

GEORGE B. SUTTON.

Pittsburgh, Pa.

Doubts General Application of Superpower

Recently, an engineer made a talk before a Chamber of Commerce in a Midwestern city on the subject of superpower, prophesying it would soon be serving the Missouri Valley as it now serves many eastern industrial centers. The idea that remained in the minds of many listeners having no knowledge of the subject was, "Push the button and Boulder Canyon or some similar location will serve you with cheap power."

Superpower is generally thought of as a thing to be available to everyone. In many large industrial centers and metropolitan cities it may be the logical source of power; on the other hand, will agricultural districts such as found in a large area of the Mississippi and Missouri valleys offer a sufficient volume of business to pay dividends on the necessary investment in a large hydro-electric power plant and superpower transmission lines?

No matter how cheaply power can be purchased, service is a first consideration. When power is transmitted long distances through open country where high winds, sleet and thunder storms are of frequent occurrence, service can be assured only by providing emergency, or stand-by plants. In such cases the interest, depreciation and fixed charges on the duplicate investment make impossible the former because it will not pay a reasonable return on the investment.

Many cities and villages using transmission-line service for operating municipal water-works systems and having no approved emergency pumping equipment, do not realize that their rating as a fire risk is practically the same as if they had no fire protection. If they are going to use transmission-line service and want their people to secure advantageous insurance rates, approved emergency pumping equipment is necessary.

The solution of the question of cheap power coupled with satisfactory service, outside of industrial centers and the larger cities, is central stations for the large cities and the "group system" for others. Many of the small villages cannot support a local plant. A city or village large enough to support its own plant and serving a group of two or three small villages in its immediate vicinity by transmission lines, is an ideal arrangement.

Such power plants in most cases should be carefully designed Diesel-engine installations. Not always is sufficient consideration given to proper engineering,

including the size of the engines to be used and the total amount of horsepower to be installed. Such plants should have sufficient power to meet all requirements, but it is just as undesirable to install needless excess power, in which event the investment is entirely out of proportion to the output of the plant, and the load factor very low, making production costs much higher than necessary.

The Diesel engine has been on the market in this country for twenty-six years, and no prime mover, from the beginning, has proved more efficient and generally satisfactory. Numerous operating records extending over a period of years show that under ordinary conditions in both large and small installations there is no power that will successfully compete with the Diesel engine where fuel oil can be bought at a reasonable price.

It is conservatively estimated that on Dec. 31, 1923, there had been put into service 600,000 hp. in Diesel engines and that over 99 per cent of all engines sold were still in service. This business is increasing by approximately 90,000 hp. per annum. There is no type of prime mover having a more enviable record than this.

Prejudice, skepticism and adverse opinions often given by persons without any practical knowledge of this type of engine, must be avoided by those investigating its possibilities.

Omaha, Neb. B. R. HAWLEY.

Is Machine-Shop Training Essential for the Power-Plant Engineer?

Having read Mr. Knapp's article in the March 18 issue entitled, "Is Machine-Shop Training Essential for the Power-Plant Engineer?" I should like to express my views on this subject. About twenty-three years ago I served an apprenticeship as a machinist and toolmaker, and being a young man with a desire to see the world, I joined the United States Navy. After spending five years at sea in various capacities from the fireroom to the engine room, I managed to gain a fair knowledge of marine engineering and found it very essential that an engineer have a machine-shop training if he ever wished to make any progress as a marine engineer.

After I came ashore, I was more or less spoiled for shop work, as I found it too confining, so I started in again as a fireman in a large Western plant. After moving from plant to plant with a view to gaining experience, I decided to take the examination for an engineer's license, which I had no difficulty in passing. I then shifted from Coast to Coast as an engineer and machinist, working in various plants ranging in capacities from 500 to 30,000 kva. Later I decided to settle down and get a steady job and to combine the two trades of engineer and machinist.

The first position I secured was in charge of a textile factory, where the power plant consisted of two boilers, a Corliss engine, numerous pumps and a small machine shop equipped with a lathe, drill press and grinder. In addition to my duties as engineer I was to take charge of the repairs of the machines of the factory. As I had a fireman and the shop was in the same room as the engine, I took the job, starting in for a lower salary than I thought the job was really worth, but confident that my salary would be raised when I had shown that I could handle the work. After six months of successful operation with the plant and maintenance of the textile machines I was expecting a raise without asking for it, as I had been told from time to time by the owner that I was doing work that he had never had any one do before and that he hoped that I would remain in his service. After thinking the matter over, I decided that if I was not worth more money to him I would quit rather than ask him for a raise. So I secured a better position as a watch engineer in a larger plant where I had no machine work to do.

However, to cut a long story short the question is, it seems to me, Does it pay in dollars and cents for a man to be an engineer and machinist? In my case I can't say that it does, although I will admit it makes one more independent. Some day I hope to meet with some plant owner that will appreciate an engineer and machinist and one that I will not have to ask for a raise every year or so in order to live.

As far as the boiler-room engineer is concerned, I would say that he can train himself to make a good engineer if he will read and study the trade journals. Of course he must have the ingenuity to grasp his work as an engineer, and he must first take an interest in his work and consider the money afterward. And I might add by way of suggestion, do not travel too much.

Chicago, Ill. WILLIAM A. VEDDER.

I have read the article by Mr. Knapp with much interest, and while not admitting that it is essential for the power-plant engineer to have a machine-shop training, it is certainly a great advantage. The machine-shop training teaches a man the "know-why" of things, from a locknut to a flywheel key, in a manner impossible of acquirement in a power plant in a lifetime, consequently breakages and shutdowns are less frequent and any that do occur are of shorter duration.

Some years ago, when examining our main engines on a Saturday afternoon, a crack was discovered in one of the crankpins of the double-throw crank. We immediately decided upon drilling a taper hole and inserting a bolt, as a temporary repair until a new crank could be obtained. A local firm was called in to do the job, and the quickest time offered was one week. Fortunately, or otherwise, I recalled a similar experience in which as a boy I took part. In this case everything had been made ready beforehand, and we started the job at noon Saturday and the engine was operating as usual Monday morning. We decided to make this repair in a similar manner and as a result the engine was in operation again on Tuesday morning and ran almost continuously for three months until the holidays, when a new crank was put in.

The majority of accidents in the power plant are caused by simple things, such as a slack nut or key, and the man trained in the machine shop must have a keen perception of these little things, otherwise his training has been wasted.

In the matter of boiler control and combustion, although I got more than my share of this as a boy, I do not look upon it as equal to a machine-shop training for an engineer. The man trained up from the boiler room must, in the natural course of things, make this his strong point, and with the present cost of coal it is an important one, nevertheless it is much easier for the engineer to get down to things of this sort than it is for the boiler man to climb up. It is always possible when things are running smoothly to get a little experience in handling the shovel or operating the stoker.

Belfast, Ireland. F. P. TERRY.

Utilizing Boiler Blow-Down

In the editorial in the April 1 issue entitled "Utilizing Boiler Blow-Down," I notice that mention is made of utilizing the heat and water in the blow-down for evaporation and the recovery of the heat in the evaporator condenser in heating the feed water.

This is interesting to me, for the reason that the process of utilizing heat and water in boiler blow-down in evaporators for producing boiler makeup feed is broadly covered by my U. S. Patent 1,393,800, dated Oct. 18, 1921, application filed April 23, 1918. A triple-effect layout in which this process of recovering the heat from blow-down waters is practiced is described and illustrated in my booklet, "Distilled Water for Boiler Makeup Feed." (See pages 3 to 6 inclusive.) This triple effect, at the advice of the late Frederick Sargent, was ordered by the Chile Exploration Co. in 1916 and was put into service at its power plant at Tocopilla, Chile, in 1917.

The first claim of the patent covers the use of the heat in the blow-down waters, and the fourth claim relates to the recovery of the water in the blow-down; that is, making the blow-down water a part of the water evaporated in the evaporator by the heat in the blow-down. This first claim reads as follows:

> The process of utilizing heat in hot water in steam power plants consisting in leading it into a space in which is maintained a lower pressure than the pressure corresponding to the temperature of the water, in employing the resulting flash vapors in an evaporating plant to evaporate water for the production of vapor and distilled water, and in using the vapor for heating the feed water for the boilers.

In the circular Form 100 E, October, 1923, issued by our company, this claim is shown above Fig. 1. It refers there to the deaërating of boiler-feed water by flashing it down a number of degrees and employing the resulting flash vapors in an evaporating plant for the production of vapor and distilled water, and in using the vapor for heating the feed water for the boilers. Two illustrations are included, which show the arrangements of the apparatus for practicing this deaërating process.

S. MORRIS LILLIE,
The Sugar Apparatus Manufacturing Co.
Philadelphia, Pa.

Heat Transfer with Superheated Steam

In a comment in the March 25 issue M. Hirsch again raises the question of heat-transfer rates obtained with superheated steam in closed heaters. Having assisted B. C. Sprague in making the tests that are mentioned in his article, I can assure Mr. Hirsch that the results were not due to any special constructional arrangements or to abnormal water and steam velocities, as he suggests. The greater part of the tests were made in a single-tube experimental condenser, both with and without lagging on the outside; velocities of water ranged from 3 to 12 ft. per sec. The superheated steam was admitted at the top of the condenser near the center. A 1,000-sq.ft. condenser and a submerged-type coil evaporator were also tried.

Mr. Sprague's contention is that with equivalent conditions the total amount of heat transferred in a bleeder heater or evaporator will not be less with superheated steam than with saturated steam at the same pressure. With constant water velocity the temperature rise of the water in any section of the tube length is proportional to the amount of heat transferred in unit time.

With the same inlet-water temperature and the same water velocity the temperature of the water at any point in the length of the water pass will be higher the greater the rate of heat transfer through the surface over which the water has passed. Unless the rate of heat transfer is as great, the temperature of the water in any point in the length of the water pass will be less when superheated than when saturated steam is used.

The temperature difference between two points is proportional to both the rate of and the resistance to heat transfer between these points. Since with equivalent conditions the resistance to heat transfer from the cooling water to the steam side surface is not affected by the substitution of superheated for saturated steam, it will be seen that the temperature difference between those points is proportional to the rate of heat flow, in either case. Unless the rate of heat flow is as great with superheated as with saturated steam, this temperature difference will be less.

The temperature of the discharge cooling water and the temperature difference from the water to the steam side of the tube cannot be so great with superheated as with saturated steam unless the rate of heat transfer is as great. It follows, therefore, that the temperature of the steam side surface will be less with superheated steam than with saturated unless the rate of heat transfer is equally great.

As the steam side surface cannot exceed the saturated temperature when saturated steam is used, it will be seen that unless the heat transfer with superheated is as great as with saturated steam, the temperature of the steam side surface will be below that corresponding to the steam pressure.

If, in a condenser or water heater having a mean cooling water temperature of 100 deg. F. and supplied with saturated steam at 150 deg. F., the rate of heat transfer was 20,000 B.t.u. per sq.ft. per hour, the coefficient of heat transfer would be 400 B.t.u. per hour per sq.ft. per deg. temperature difference. If superheated steam at the same pressure were supplied having a temperature of 200 deg. F., the rate of heat transfer would be the same, giving the same mean cooling-water temperature.

If it were attempted to figure the coefficient of heat transfer from the actual mean temperature difference, a value of 200 would be obtained. If the superheated steam temperature had been 500 deg. F., the coefficient of heat transfer would figure to be 50. It is seen that the coefficient of heat transfer has no relation to the actual amount of heat transferred at the same pressure.

A prominent manufacturer of desuperheating equipment recently published a pamphlet in which the results of tests are cited showing that greatly reduced coefficients of heat transfer were obtained with superheated steam. The inference is that the rate of heat transfer is improved by desuperheating the steam. From the example cited it is easy to see why the lower coefficients of heat transfer are obtained with superheated steam, although the rate of heat transfer in B.t.u. per sq.ft. per hr. with steam at the same pressure is the same. A great many who are not familiar with heat-transfer calculations are misled by such statements, and the writer challenges anyone to show reliable tests, which, with the same pressure steam and other conditions, will show that the heat transferred per square foot per hour was increased by desuperheating the steam.

Springdale, Pa. C. E. COLBORN.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Bent Rocker on Single-Valve Engine

Why do some designs of single-valve engines employ a bent rocker for imparting motion to the valve? *L. T. B.*

With a straight rocker the valve may have equal laps and equal port openings, but from the angularity of the connecting rod the piston positions at cutoff will be unequal and equal cutoff can be obtained only at the expense of the lead. By using a bent rocker, an irregularity is introduced which is made to equalize more nearly the cutoff without interfering with the equality of the leads.

Movement of Engine in Valve Setting

In setting valves, should the engine be turned forward or backward? *R. L. G.*

For all operations of valve setting the engine should be turned in the running direction. Then the lost motion or backlash of connections will be taken up in the same manner as when the engine is in operation. In making adjustments, if the valve gear is moved beyond the intended position, the parts should be brought to the correct position by completing the forward rotation of the shaft, or turned backward well beyond the desired position and again brought up to that point with motion in the running direction.

Use of Zinc To Prevent Boiler Corrosion

How are zinc plates used to prevent corrosion of boilers, and are they efficient for that purpose? *H. M. F.*

The material of the plates should be about 98 per cent pure zinc. As generally used, the fresh plates are about $\frac{1}{4}$ in. thick and of convenient size for handling and to avoid waste in cutting. The size usually employed is 6 by 10 or 12 in. with a central hole $\frac{3}{4}$ in. in diameter for suspending the plate in the boiler water from brackets or stays with ferrules between the plates so the water may have free access to the entire surface. However, the zinc may be in the form of blocks, slabs or as shavings suspended in a perforated vessel. In marine practice it is customary to allow $\frac{3}{4}$ sq.ft. of zinc surface (not counting the edges of plates) for each 100 sq.ft. of boiler-heating surface; or ordinarily there may be exposure of about one square inch of zinc surface for every 50 lb. of water in the boiler, although the quantity should vary with the hardness of the water. The zinc must be suspended and connected in such a manner as to insure perfect electrical contact with the material of the boiler. A basket is so suspended from the zinc as to catch pieces of zinc oxide that may scale off. For the best effect the zinc should be near the incoming feed water, to neutralize the oxidizing effect of air liberated by the feed water, and in such other places in the boiler as may be especially subject to pitting.

The theory on which the zinc acts to save the boiler metal is based on the fact that it is electropositive as compared to iron, so that when immersed in the boiler water a current is set up and flows from the zinc to the iron, with the result that the zinc oxidizes and corrodes and the iron does not. However, zinc oxide is electronegative to iron, and when sufficient of the zinc oxide adheres to the zinc, the current may reverse and the iron will corrode faster than if no zinc were present. Hence, to prevent reversal of the desired action, the zinc must be kept clean and free from scale. It is questionable what efficiency the zinc may have except for a short period after installation and when the contact with the boiler is known to be positive.

Allowance for Friction Between Plates of Riveted Joints

In estimating the strength of riveted boiler shells, what allowance is made for the frictional resistance between the plates due to the force with which the plates are drawn together by driving and cooling of the rivets? *J. L.*

Friction between the plates undoubtedly enhances the holding power of riveted joints, but the resistance is always a matter of doubt and therefore should not be taken as a basis of calculation. Tests of joints have shown that when the plates are new and clean, a slip occurs long before the working load of the joint is reached. Such tests have also shown a wide variation in results, depending on the plate surfaces, but in all cases slippage occurred when the load was only a fraction of the ultimate strength of the joint.

Mixed-Pressure Turbine Operating on Low-Pressure Steam

An impulse type of mixed-pressure turbine operates on low-pressure steam but cannot operate on high-pressure steam. What can be the cause? *G. F. W.*

Some impulse turbines are designed to admit low-pressure steam until the demands of the load require more than the available low-pressure steam. In such a case high-pressure steam is opened up. If you have sufficient low-pressure steam to carry your load, the turbine will not operate on high-pressure steam. If the turbine will not cut over on high speed when the low pressure is shut off, causing the machine to lose the load, something is out of adjustment with the valve gear, preventing proper opening of the high-pressure valve.

Measuring Cylinder Clearance Volume

How can measurement be made of the volumetric cylinder clearance of an engine? *B. J. W.*

The volumetric clearance is not only the space in the bore of the cylinder when the engine is on a center, but includes the volume of the ports back to the valve faces and volume of any fittings, such as indicator piping, which may be connected with the cylinder when the engine is in operation, and may have different values at the head end and crank end of the stroke.

The volumetric clearance may be estimated from the drawings or actual measurements of the engine, but these give only an approximate result. A better method is by water measurement. For this purpose place the engine on the desired dead center, with the piston at the end where the clearance is to be determined. The steam valves should be made watertight by smearing their faces with heavy cylinder oil, and a slide valve, which has any part of its face below the level of the highest part of the clearance space, should be made tight by clamping sheet packing between the valve and its seat. The piston and cylinder bore should be well oiled to hinder leakage of the water which is to be placed in the clearance space. For a Corliss engine or one in which the valve seat is at the highest level of the clearance space, the best method is to remove the valve, so as to obtain access to the whole steam port and then fill up the clearance space with water poured into the open port through a funnel, or with the space vented of air the water may be poured through an indicator connection. If the connections are on the side of the cylinder, they may be turned or extended high enough to form a standpipe in which the water may be filled to the level of the highest part of the clearance spaces. The water used for filling is to be taken from a receptacle containing a quantity previously weighed, and the initial gross weight of water and container are observed. The time required for the filling is to be noted, and when the whole space, including ports, is completely filled, the container and water left are weighed. The difference between the initial and final weights will show the amount of water that has been poured in, and the corresponding volume is found, allowing 0.0361 lb. per cu.in. of water when used at about 62 deg. F.

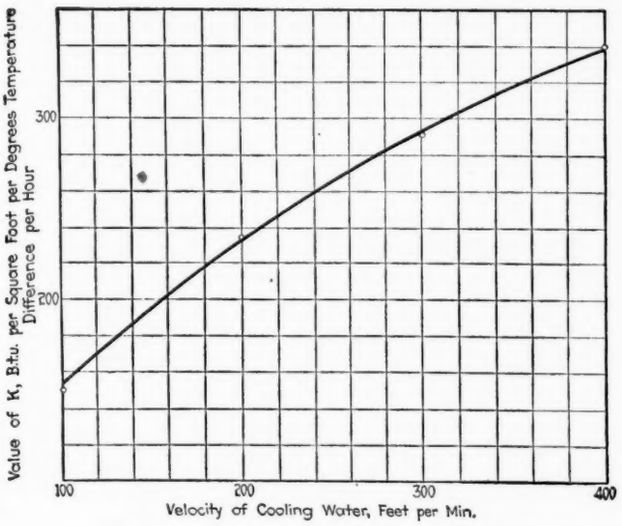
A slight amount of leakage cannot be prevented and, when not too serious, determination can be made of the approximate rate of leakage. This is done by measuring the amount of water necessary to be added to keep the clearance space filled for one minute. This would be the maximum rate of leakage, since during the filling the leakage probably varies with the head of water in the cylinder, and for most practical purposes it may be assumed that the average rate during filling is one-half the amount thus shown. Then the number of minutes required for the filling should be multiplied by one-half the maximum rate of leakage, and this weight subtracted from the weight used for filling gives the weight corresponding to the actual clearance volume. For accurate results several determinations should be made and none should be accepted unless the results show fair agreement.

The proportion of clearance is the volume in cubic inches thus found divided by the volume in cubic inches swept through by one stroke of the piston; that is, the clearance volume is to be divided by the area of the piston in square inches times the stroke in inches.

Heat Transfer in Ammonia Condensers

In checking up the amount of coil surface of ammonia condensers offered by two manufacturers, I notice that one has almost 50 per cent more surface than the other. Why is this, and how does one calculate the surface needed? *C. N. H.*

The heat in the ammonia must pass through the pipe coil to the water. Three things operate to oppose this flow of heat. In the first place the condensing of some of the ammonia coats the ammonia side of the pipe with a liquid film which offers resistance to a flow through it to the pipe. The metal of the pipe also offers a resistance while on the water side of the pipe there



Coefficient of heat transfer in double-pipe ammonia condensers

is a more or less stationary film of water and air which greatly impedes the flow.

The conductivity through the three resistances may be written as

$$K = \frac{1}{\frac{1}{c_1} + \frac{1}{c_2} + \frac{e}{c_3}}$$

when

K = Heat transmitted per hour in B.t.u. per deg. temperature difference;
c_1 = Coefficient of transmission for the water side film;
c_2 = Coefficient for the ammonia side;
e = Thickness of pipe in inches;
c_3 = Conductivity of the pipe per inch thickness.

The use of this formula entails information as to the several coefficients, and a general value of K is taken. It has been found that the condition on the water side has the greatest influence and changes in water velocity by altering the film conditions affects the coefficients to a marked extent. In the illustration is given a curve showing values of K for double-pipe condensers established by experiments at different velocities; the proper value for any velocity may be taken from the chart.

[Correspondents, sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Perfect and Actual Engines

IN MOST fields of engineering so many factors enter in, some of which are only partly understood, that a complete theory is out of the question. In order to solve problems, certain fictions are invented that correspond more or less closely to the facts. These fictions are chosen largely for their simplicity. They must act in accordance with perfectly definite rules and be easy to figure with.

The results computed on the basis of such a fiction or thory will always be in error if applied without correction to an actual machine, but the error may be largely corrected by the use of "factors" based on experience. Like the "factor of safety" used in design, these are really nothing but "factors of ignorance" or "factors of convenience" that take care of elements not understood, or at least not considered by themselves. They are factors determined by experience, which, when multiplied by the "theoretical" results (figured on the basis of some easy fiction and neglecting most of the difficult facts), will give a result reasonably close to that obtained in practice.

Perfect Engine a Fiction

A good example of such a fiction is the "perfect engine." There are no "perfect" engines nor will any ever be constructed, but the idea has been wonderfully fruitful in the study of actual engines and turbines.

The actual engine is really a very complicated piece of apparatus if consideration is given to all that is taking place. To account properly for all these changes by actually reasoning out what must happen in each detail is beyond the power of any living man. Yet final over-all results can be predicted with reasonable accuracy from experience with similar engines under similar circumstances. The first step is to measure the performance of an actual engine and compare it with that of the perfect engine operating with the same throttle steam conditions and exhaust pressure. Dividing the actual performance by that of the perfect engine gives a factor, which, if multiplied by the performance of the perfect engine, will give that of the actual engine.

The correctness of this simple operation would be evident to anyone who understood arithmetic even if he knew nothing of steam engineering. However, all that the arithmetician could be sure of would be that the factor would work all right for the particular case from which it was derived. If it could not be applied elsewhere, it would be of no practical value. But thousands of steam engine and turbine tests have been made in which the factors have been figured. Tabulation and study of these tests show that a certain factor will hold fairly well for a given general type of engine over a fair range of size, throttle conditions and exhaust pressure. It is then permissible to apply the factor obtained for one engine for another of the same general type provided that the size and steam conditions are not too different.

The perfect engine considered is one in which there is no friction or throttling and in which no heat passes from steam to metal or vice versa. In the more commonly assumed type of perfect engine expansion is complete to the back pressure. In this particular it corresponds to an actual steam turbine or to an actual steam engine whose expansion line just reaches the exhaust line at the end of the working stroke.

Steam Rates of Perfect Engines

The steam rates of perfect engines (and perfect turbines) for various initial pressures and superheats and various back pressures are shown in the table. These are figured from the "Mollier" Chart, in which vertical lines represent expansion in a perfect engine and vertical distances the heat drop during expansion. The "heat drop" obtained for any given initial steam condition and exhaust pressure represents the amount of work (in B.t.u.) done by the expanding steam. This must be true for the assumed ideal conditions because no heat passes from steam to metal, so heat can disappear only by producing an equivalent amount of work. It is not difficult to figure the water rate of the ideal engine from this heat drop. For example, the Mollier diagram shows that when steam expands in a perfect engine from 100 lb. gage (saturated) to a back pressure of 5 lb. gage, each pound of steam delivers 130 B.t.u. as mechanical work.

One horsepower is equal to 2,545 B.t.u. per hour, so a perfect engine working under these conditions would consume 2,545 ÷ 130 = 19.6 lb. per hour for each horsepower delivered, as shown in the table.

Since the performances given in the table are expressed in steam consumed per horsepower-hour, it is evident that the factors will always be greater than unity since an actual engine must always consume more steam than a perfect one for the same power output.

Now for the practical application of this table. A reciprocating engine with throttle conditions of 100 lb. gage and 100 deg. superheat exhausts at about atmospheric pressure. If the present steam consumption is 30 lb. per i.hp.-hour, what will be the approximate increase in the steam consumption if the back pressure is raised 5 lb.? The present factor is 30 ÷ 16.0 = 1.87; that is, the engine consumes 1.87 times as much steam as a perfect engine. Since the contemplated change in conditions is not great, it is fair to assume that the same factor will hold pretty well if the back pressure is raised 5 lb. For the new conditions a perfect engine would take 18.2 lb. per i.hp., so the actual engine would consume about 18.2 × 1.87 = 34.0 lb., an increase of 4.0 lb. per i.hp.-hour. This shows the importance of slight changes in back pressure.

Effect of Better Vacuum

Again, to see the effect of small changes in vacuum, consider a steam turbine consuming 14 lb. of steam per kilowatt-hour when taking steam at 200 lb. gage and 100 deg. superheat and expanding down to a 28-in. vacuum. It will be unnecessary to reduce the steam consumption of the perfect engine to the horsepower basis, as this will be taken care of in the factor.

Dividing 14 by 7.1, we see that the actual turbine consumption per kilowatt-hour is 1.97 times that of a perfect engine per indicated horsepower-hour. At a vacuum of 29 in. the perfect engine takes 6.5 lb. per i.hp.-hour, which, multiplied by 1.97, gives 12.8 lb. per kw.-hr. for the actual turbine at the better vacuum.

Care must be taken not to apply this method for large changes of back pressure or superheat, as the factors themselves vary appreciably in such cases unless the engine or turbine is redesigned for the changed conditions. This is particularly true of superheat, which causes the performance of the actual engine or turbine to approach more nearly to the ideal On the other hand, particularly with turbines, a fairly large change may be made in the initial pressure without seriously affecting the factor.

STEAM RATES OF PERFECT ENGINES, POUNDS PER I.HP.-HOUR
(Complete Expansion)

Initial pressure, Lb. per Sq.In. gage		100	100	200	200	200	300	300	300
Initial superheat, deg. F.		0	100	0	100	200	0	100	200
Back pressure	5 lb. gage	19.6	18.2	14.6	13.5	12.4	12.6	11.7	10.8
	Atmospheric	17.1	16.0	13.2	12.2	11.3	11.6	10.8	10.0
	28-in. vacuum	8.5	8.0	7.5	7.1	6.7	7.0	6.6	6.2
	29-in. vacuum	7.6	7.2	6.9	6.5	6.1	6.5	6.1	5.7

Generation and Utilization of Steam in Iron and Steel Industry*

BY JOHN A. HUNTER†

TO GENERATE steam for all purposes, approximately 16,150,000 gross tons of coal and blast-furnace gas equivalent to 6,050,000 gross tons of coal are used each year, in the iron and steel industry, or a total of 22,200,000 gross tons of fuel. At an average price of $4 per gross ton the cost is $88,800,000. To convert this fuel into steam costs $38,870,000, making the total cost of generating steam $127,670,000. The rated capacity of the boilers used to generate the steam is about 2,650,000 hp. The steam is used in approximately 8,600 prime movers having a rated capacity of 4,900,000 hp., and for process work. About 4.3 lb. of coal is required to produce a brake horsepower-hour.

Boilers, Superheaters, Feedwater, Etc.

Table I shows the number, type, and size of boilers used by several of the largest steel companies, and is probably representative of the entire industry.

The boilers that are now being installed will probably average 8,000 sq.ft. per unit, the maximum size being about 20,000 sq.ft. The vertical and inclined-tube types are still the most popular. They are constructed for a maximum pressure of 300 lb.; however, 200 lb. is the pressure for most installations.

Probably 15 per cent of the present boilers are equipped with superheaters for an average of 75 to 100 deg. F. superheat. Practically all new boiler installations include superheaters to yield an average superheat of about 100 deg. F., with maximums of 200 deg. F.

Economizers have been installed to a limited extent, not over 10 per cent of the total boiler capacity being equipped. Most of the installations have cast-iron tubes and are of the separate type. The recent installations are of the integral type with either cast-iron or steel tubes.

Of the coal-fired boilers probably 75 per cent are equipped with stokers. Most of the older installations are natural-draft chain grates. Recent installations are practically all forced-blast, of the underfeed or chain-grate types.

TABLE I—CLASSIFICATION OF BOILERS

	Percentage of Total Number Classified*				
	200 Hp. and Below	Above 250 Hp. to 500 Hp.	Above 500 Hp. to 1,000 Hp.	Above 1,000 Hp.	Total
Vertical water-tube	25.6	34.0	3.6	0.1	63.3
Horizontal water-tube	15.6	11.0	0.9	0.7	28.2
Return-tubular	8.5	....	...	...	8.5
Percentage of each size	49.7	45.0	4.5	0.8	100.0

* Total number of boilers classified, 2,799.

Powdered coal has not been used to a great extent. In some works where it is used for metallurgical purposes it is also used under boilers. Recently, several plants having a total rated capacity of 15,000 to 20,000 hp. have been equipped to use powdered coal from individual pulverizers. Some works are also using powdered coal to supplement blast-furnace gas.

Auxiliary Equipment

Auxiliary equipment is largely steam-operated, particularly in the older installations. The reciprocating-type feed pump is used to the greatest extent, but practically all recent installations are of the centrifugal type, both motor- and turbine-driven. Stokers and fans in the older installations are driven by small engines; for the new installations motors and turbines are employed.

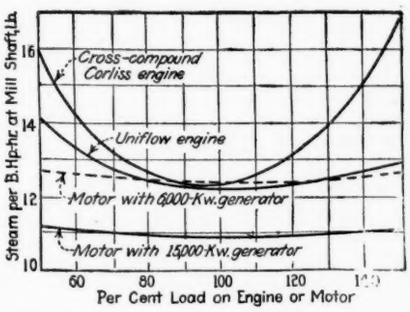
The steel industry has been a pioneer in the development of regulating equipment and still employs automatic control to a greater extent than central-station plants.

The average output obtained from boilers in operation is about 110 per cent of rated capacity. Recent installations are operated at a continuous rating of 150 to 200 per cent of rated capacity. These ratings may seem low compared to those obtained from central-station boilers, but in making such a comparison the operating conditions must be considered. In central-station boilers, condensed steam with a slight percentage of makeup water is used for feed purposes. In steel works the steam is ordinarily used at widely separated points which are so far from the source that it is impracticable to return the condensate, consequently the feed-water contains more or less incrusting solids. The high ratings obtained from central-station boilers are seldom continuous throughout the twenty-four hours, while in steel works the load is fairly constant for six days per week.

The average steam pressure carried is about 140 lb. gage; the maximum pressure, about 300 lb. gage.

In 1919, according to the U. S. Census figures, there were in the steel industry 6,796 steam engines having a total capacity of 3,243,347 hp. or an average capacity of 478 hp., and 922 turbines of a total capacity of 863,026 hp., or an average of 936 hp. Although the total rated capacity of steam prime movers increased 37 per cent from 1909 to 1919, the total number decreased 8.5 per cent and the rated capacity decreased from 91.3 per cent to 76.0 per cent of the total capacity of all prime movers. Internal-combustion engines show some increase, but the greatest increase has been in the use of electric power. The total capacity of motors increased from 851,752 hp. in 1909 to 2,593,150 hp. in 1919, or over 200 per cent. The use of purchased power shows an even greater increase, more than 900 per cent, which would indicate not only a pronounced tendency toward electrification, but also toward the use of central-station power.

The size and kind of engines in use vary widely, practically every known type being represented. They are both condensing and non-condensing, most of the larger engines being compound condensing.



Typical water rates for steam engines and turbo generators

The turbine is used extensively, in small sizes to drive fans and pumps, and in the larger sizes to drive generators.

Two of the largest manufacturers of turbo-generators have sold to the iron and steel industry 334 units varying in size from 300 to 17,000 kw. and having a total capacity of 908,425 kw., of which 39 per cent has been installed since 1918.

Turbines also seem to have replaced the large gas engines for driving generators, for since 1918 only five gas engines, having an aggregate capacity of 21,140 kw., have been installed.

Although these figures indicate an increased use of turbo-generators and motor drives, the development of the unaflow engine has been responsible for the installation of a great many steam engines. This engine is particularly adapted to mill drives on account of its economy with variable loads and its large overload capacity. The curves in Fig. 1 show typical water rates per delivered horsepower at mill shaft for unaflow and compound engines, and for 6,000- and 15,000-kw. turbo-generators with motor drives for mills.

These curves show clearly the advantage of the unaflow engine over the compound engine for variable loads.

*From a paper presented at the Spring Meeting of the American Society of Mechanical Engineers, Cleveland, Ohio, May 26 to 29, 1924.

†Steam and Sanitary Engineer, American Sheet & Tin Plate Co.

At full load the difference in the water rate is slight, but as the load changes the difference in favor of the unaflow becomes greater and is quite large at low and high ratings. The unaflow engine has a better water rate from about ¾ load to 1¼ load than the 6,000-kw. turbo-generator with motor drive. The curve for the 15,000-kw. unit shows the effect of increasing the size of the turbo-generator.

Several recent studies made to determine the most economical mill drive would indicate that in general, when all conditions are considered, the unaflow engine is more economical for works where the capacity of the turbo-generator is less than about 6,000 kw.

Waste-Heat Utilization

Within the last few years the utilization of waste heat has been given a great deal of consideration, as is shown by the kind of equipment being installed for that purpose. The largest source of waste heat is blast-furnace gas. In 1919 enough of this was used for operating gas engines and producing steam to replace 7,259,878 gross tons of coal. Of this, 1,204,821 gross tons coal equivalent was used in gas engines, leaving 6,055,057 gross tons coal equivalent used for producing steam.

Byproduct coke-oven gas is used to some extent for producing steam, but this gas is too valuable a fuel to be used for steam purposes and is generally used in open-hearth and heating furnaces. In some places it it used over Saturdays and Sundays for generating steam.

Coke breeze—waste fuel from coke ovens—is used for the production of steam. The development of the forced-blast chain-grate stoker has made it possible to burn this fuel efficiently. However, the total amount used is relatively small.

At present the iron and steel industry is producing power at an average rate of 56,000 B.t.u. or 4.3 lb. of coal per b.hp.-hr., and the best practice is at the rate of 18,000 B.t.u. or 1.4 lb. of coal per b.hp.-hr.

Taking the year 1919 as a basis, with a production of 30,543,167 gross tons of pig iron and 33,289,939 gross tons of steel ingots, it is estimated that it will be necessary to produce 10,410,000,000 b.hp.-hr. To produce a brake horsepower-hour will require 1.4 lb. of coal or a total of 6,500,000 gross tons of coal.

For process steam and heating buildings 1,670,000 gross tons are required, or a grand total of 8,170,000 gross tons per year for the industry.

From the blast furnace it has been shown that with the present practice there is available 6,055,000 gross tons of coal equivalent. It is estimated that by stopping bleeder losses and increasing the efficiency of the stoves, 2,345,000 gross tons of additional blast-furnace gas will be made available, making the total coal equivalent of blast-furnace gas 8,400,000 gross tons, which could be used to generate steam. From this it is seen that there is enough waste heat available from the blast furnaces, without considering additional heat from other sources such as open-hearth furnaces, heating furnaces, etc., to produce all the steam required in the industry. This would mean a saving of 16,150,000 gross tons of coal per year, which at an average price of $4 per gross ton equals $64,600,000; also a saving in the cost of operating the boiler plants of $33,140,000, making the total saving per year $97,740,000.

In order to accomplish this desideratum it will be necessary to provide means to utilize the extra power at times and at works where there will be a surplus. This situation exists in several of the large steel centers, and has been solved by installing large turbo-generators and using electric drives for the mills, and connecting several works together with high-tension electric transmission lines. In addition to this, in some cases the power system is connected to a central-station power system and contracts are made for the interchange of power. This arrangement is advantageous to both parties, and through agreements of this kind it will be possible to utilize the waste heat of the industry to the fullest extent.

The subject is now being studied by several of the large steel and central-station companies, and no doubt in the near future most of the large steel works will be tied in with central-station systems. When this is done, it will be possible to conserve all of the surplus waste heat from unbalanced works and the heat that is now wasted over Saturdays and Sundays when the finishing mills and other equipment are not in operation.

Lubrication of Hydraulic Turbines

Last year a subcommittee of the N.E.L.A. Hydraulic Power Committee was appointed with C. F. Mosher, chairman, to investigate lubrication practice in hydro-electric plants. A questionnaire was sent out to a number of companies, and the following is a summary of the replies as given in the Hydraulic Power Committee's 1924 report under the title "Constructive Criticism of Lubrication Methods"

IN A STUDY and discussion of lubrication methods the interest and discussion seemed quite naturally to center upon the vertical single-runner type of unit, probably due to the growing popularity of this type for many conditions.

Five correspondents only mention horizontal-shaft wheels. Two having horizontal-shaft wheels with submerged bearings are experimenting with forced-grease lubrication for lignum-vitæ and babbitt-lined bearings, and one is experimenting with forced grease lubrication for submerged gate stems, shifting rings and levers. One correspondent merely mentions the fact that he is operating some horizontal-shaft machines and then goes on to discuss lubrication of vertical units, operated by the same organization. One letter, after a brief description, closes with this sentence—"It would seem that machines of this size and type are easy to lubricate and do not present any real lubrication difficulties." One correspondent wrote of a 13-unit, 130,000-hp. horizontal-shaft installation, having ordinary ring-oiling bearings—"The oil in these bearings lasts a great many years and the amount required for renewal is comparatively small."

It seems that when the first large stations using vertical single-runner units were built several years ago, there was an almost universal adoption (for babbitted and roller bearings) of central lubrication systems, involving extensive piping, pumping, continuous filtration and cooling layouts with a large volume of oil in the system.

These systems, so far as the correspondence shows, have been remarkably successful in operation, and it is interesting to note that the criticisms offered have all been toward simplification and unification of lubricating systems, a strong tendency showing at the present time for unit systems for each machine, with a small filter, storage and cooling tank and individual circulating pump all located in the pit under the generator and designed usually to circulate continuously a much smaller volume of oil than has been customary.

Illustrative of the general satisfactory performance of the central lubrication systems two of the correspondents, who are soon to make further installation of vertical single-runner units, have expressed themselves as intending to confine the oil for the supporting bearing to its own chamber; (carrying away the generated heat through water-cooling coils) and using a small gear pump to handle the oil from the babbitted guide bearings, using the supporting bearing chamber as a source of supply to the guide bearing and make provision for periodic change and filtration of the oil, but will not make any change in the present central lubrication systems.

One correspondent writes as follows: "We have several units which have a large container for the thrust bearing in which the oil is not circulated and is kept cool by means of water-cooling coils installed in the thrust-bearing chamber. They are operating very satisfactorily."

Another correspondent is using and highly recommending a unit system without continuous filtration and with arrangement for adding makeup oil from the governor pressure line, apparently using the same oil for lubrication and governor service.

One correspondent writes of a recent 70,000-hp. vertical-shaft single-runner unit, having a thrust load on the bearing of 1,000,000 lb. with a supporting-bearing chamber holding 600 gal. of oil provided with water-cooling coils for carrying off the generated heat. The oil for this bearing is not continuously circulated and filtered, provision being made for periodic change and filtration only. The babbitted guide bearings for

this unit are lubricated through separate connection to an older central system with a small independent pump and feed line for isolated operation. A very high viscosity oil is used in this unit.

The reasons assigned for preferring simple self-contained or unit systems are the difficulty of maintaining tight joints in extensive piping systems, the suspicion that continuous churning of warm oil through the overflow piping systems and centrifugal pumps doesn't improve its lubricating qualities, an unexplained loss of oil from the large systems, and the greater ease and less expense with which oil in a unit system may be changed, treated or discarded.

One correspondent having a central system containing about 5,000 gal. of oil, in continuous use for eight years with makeup only added, writes that although temperature indications, viscosity tests, etc., show that the oil is still good, it is considerably darker in color than the new oil, and he would like to replace it on general principle if it didn't cost so much, not only in cost of replacement oil but cost of emptying and refilling the central system while maintaining regular operation.

There seems to be general agreement among all correspondents that the use of oil or water flow indicators (whichever medium is circulated), temperature indicators and alarms, and recording thermometers, is practically essential to reliable operation.

Life of Lignum Vitae Bearings

On large single-runner vertical units the use of a lignum-vitæ lined, split sleeve, water-lubricated bearing, without adjustment for wear, located and supported on the casing head with the runner overhung, has been almost universal. On smaller units and large units for high heads the use of a babbitt-lined oil-lubricated, segmental bearing with sliding-wedge adjustment has been quite common and successful in operation. Reports on the lignum-vitæ lined bearing show wide variations, some correspondents reporting eight and ten years' life before relining and others relining in two to three years. The waterwheel manufacturers lay a great deal of stress on having a supply of clear, grit- and sediment-free water for lubricating purposes, but most users seem to have found river water, screened through a fine-mesh screen, to have been satisfactory except for short periods during freshets, when an auxiliary supply is usually in service.

One correspondent writes of a case where rapid wear and necessity for frequent replacement were found upon careful check to be due to an eccentricity of approximately ⅛ in. between the rabbet on the head cover and the bore of the bearing housing. This was remedied by boring the lignum-vitæ lining with an offsetting eccentricity, with markedly longer life for the bearing lining and the bronze sleeve on the shaft.

One correspondent reports the use of white-oak blocks on edge instead of lignum-vitæ for lining purposes and the practice of once shimming out and reboring of the lining blocks as a measure of practical economy, the white-oak blocks giving apparently as good service as the lignum-vitæ blocks.

The penstock or wheel case is usually tapped for one source of water supply, and one other source is considered necessary, either from a reservoir, pumping system and well supply or settling basin. The penstock supply on most rivers is unfit for use during freshet flows, and there is always the possibility of leaves and small débris, and in some cases frazil ice closing off the flow. Sight flows and alarms are considered an absolute necessity.

There has been an almost universal demand from operating organizations for a bearing next to the runner with adjustment provision for taking up wear and at least one of the large waterwheel manufacturers has developed such a bearing with a few large installations already in service.

Fuels for Diesel Engines*

By R. Schlatter†

In discussing the future of the fuel supply for Diesel engines, it may be observed that the fuel-oil production in the United States in 1923 amounted to about 725,700,000 bbl., representing a 30 per cent increase over 1922. It is more than twice the output of 1918. It is approximately 40 million barrels more than the total world's production in 1920. In 1923 about 82 million barrels of crude petroleum was imported, while the export of crudes was only 17 million barrels. The stock increased more than 79 million barrels. At the end of the year the total stocks amounted to 333 million barrels, sufficient at the December rate of consumption for 163 days.

In this connection it may also be mentioned that the Department of the Interior reports annual consumption of fuel oil for production of electricity of about 13,200,000 bbl. for 1922. It is estimated that of this about 12,000,000 bbl. was burned under steam boilers in electric-generating stations. Assuming a price of $1.50 per barrel and a fuel consumption ratio of 1 to 2 (0.6 lb. against 1.2 lb. per kw-hr.) the saving that could be effected by burning this oil in Diesel engines instead of under steam boilers would amount to $9,000,000 per annum.

One of the chief advantages of the Diesel engine is that it can work with oils of a high flash point. The number of fuels suitable for Diesel engines is consequently very great.

In this country, where crude petroleum is available in abundance and at reasonable prices, such oils are, of course, the first to be considered. In some cases petroleum is used as a fuel in the crude state, after being stored for some time in order to free it from water, sand and other impurities. These oils are known as crude oils or crude petroleums. This is the strict meaning of "crude oil." The same name is also widely used to designate the heavy oil left after the lighter constituents have been distilled off. Generally, however, it is much more profitable to separate out the lighter constituents, gasoline, illuminating oils, paraffin oils, etc., by distillation and to use the fractional distillates (gas oil) so obtained, as well as the residual heavy oils for running Diesel engines.

There are many methods of working up crude petroleum oils. One of the common processes gives as a middle fraction an oil used for carburizing water gas and oil gas, hence the usual trade name of gas-oil; it is one of the best oils for Diesel engines. The heavy oils which are left after the gas oil has been distilled off, and from which lubricating oils are obtained, also must be recognized as first-class Diesel fuels, and are preferred on account of their being cheap.

Furnace oils or boiler oils, commonly called fuel oils, the residues left after the crude has been worked up for obtaining gasoline, kerosene and paraffin oil, are suitable for Diesel use, the suitability varying inversely with the percentage of constituents having very high boiling points, such as pitch.

In districts rich in lignite and shale, lignite tar-oils recovered from lignite tar and shale tar, come under consideration. In coal districts the coal-tar oils are obtained from coal tar. Available distillates from raw coal tar are medium oils, heavy oils and anthracene oils.

There is a growing tendency not to use coal directly as fuel, but to split it up by distillation into its valuable components, such as coke, gas, tar and ammonia in as rational a manner as possible, and the extension of this process will make coal-tar oils more important as Diesel fuel. As an illustration of what is going on, Henry Ford produces daily in the River Rouge coke ovens 2,000 tons of coke and as byproducts, 4,500 gal. of refined light oil, 18,000 gal. of benzol, 17,800 gal. of tar, 60,000 lb. of ammonium sulphate and 26,300,000 cu.ft. of gas.

It may seem peculiar that the quality and suitability of a tar does depend much less on the kind of coal it is derived from than on design and operation of the retorts. Vertical retorts give a more fluid tar than will horizontal retorts. Furthermore, the lower the temperature of the retort the lower also the pitch content of the tar and, vice versa, with high distillation temperatures, the amount of unsuitable components increases. The temperature also affects the quantity of tar obtainable; with increasing coking temperature the quantity of tar decreases.

Some kinds of tar under certain conditions can be used directly in Diesel engines; for example, the tar obtained from vertical retorts in gas works (which was done in the Philadelphia Gas Works in 1904); also oil-gas and water-gas tars, the residues left when making oil and water gas, can be used after they have been freed from water.

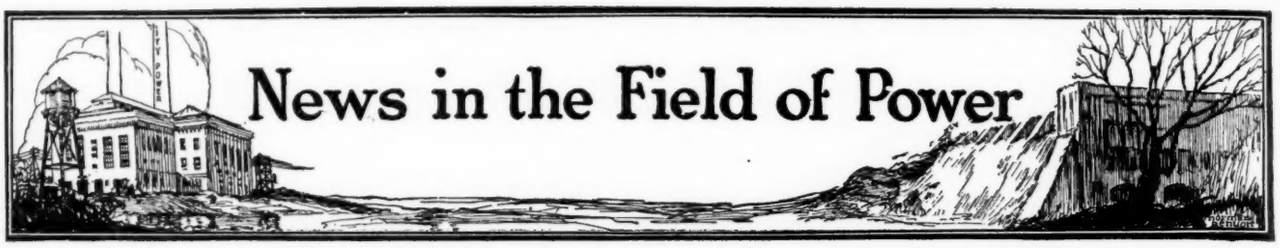
In districts where vegetable oils are produced, these can be used as fuel oils, in so far as their price allows them to compete with mineral oils.

It appears, therefore, that for several generations there will be no cause to worry about the fuel supply for Diesel engines, especially as we read almost daily of discoveries of new oil fields and coal fields in various parts of the world.

---

*Extract of paper read before the St. Louis (Mo.) Section, American Society of Mechanical Engineers, April 22, 1924.

†Engineer, Busch-Sulzer Bros.



Muscle Shoals Government Ownership Bill Reported to Senate Favorably

Ford Offer Rejected—Norris Government Ownership Amendment to McKenzie Bill Passed by Vote of 11 to 4

GOVERNMENT ownership and operation of Muscle Shoals was indorsed by the Senate Committee on Agriculture when it voted 11 to 4, on May 27, to report favorably the Norris bill as an amendment to the McKenzie bill, which has already passed the House.

Those who believe that the committee's action killed the Ford bill based their reasoning on the assumption that even should the Senate pass on the Norris bill, of which there is some doubt, the resulting conference between the two houses would end in a deadlock. Mr. Ford would not accept the compromise measure on which the Senate conferees would insist. In turn, the Senate would not accept a conference bill which would embody the few concessions which Mr. Ford might accept. It is expected however, that the Norris bill will be taken up by the Senate during the week of June 2, which will mean that there will be extended discussion of the disposition of Muscle Shoals.

No votes were taken in the committee on the other offers. It was so apparent that all of them would be voted down that no member of the committee moved to vote on that.

A subcommittee consisting of Chairman Norris, Ransdell of Louisiana and McNary of Oregon, was authorized to draft any amendments to the Norris bill as may be deemed necessary to perfect it. The amendments, however, must be reported back to the full committee for approval. The principal provisions of the Norris bill are as follows:

The Secretary of War is directed to complete Dam No. 2 (the Wilson dam) and Dam No. 3. Surveys of reservoir sites with the idea of increasing the amount of primary power. The creation of the Federal Chemical Corporation, which is authorized to use the power and the government's plants for the manufacture of explosives for the government and the manufacture of fertilizer for sale to the public. Any and all power not required by the nitrate plants may be sold. The corporation may establish agencies for the sale of its products "in order to prevent a monopoly of the fertilizer business or the undue or unreasonable advance in the price of fertilizer."

It was admitted in the committee that the principal point influencing the majority was the fact that the distribution of the power cover as wide an area as possible. They were convinced that the sale of the properties to Mr. Ford could mean nothing else than the consumption of all the power at or near the dam.

The Norris-Keller superpower bill, was vigorously opposed by Gen. Guy E. Tripp of the Westinghouse Electric & Manufacturing Co., according to recent press reports. General Tripp was reported to have said that the bill "is economically wrong and shows a distrust of private initiative in the development of the nation's power resources for the public's benefit."

"A super-power system would add to the wealth of the country only in those sections where it is needed and only to the extent that it is needed," General Tripp said in discussing the probable effects of such a measure if allowed to become law.

"The only test that can be applied is, Will there be enough demand to pay a return on the capital invested? If there is not, then, to the extent that it falls short of doing so the labor and material expended for a super-power system is national wealth wasted."

General Tripp said that the bill had been introduced jointly in the Senate and House by Senator Norris of Nebraska, and Congressman Keller of Minnesota, and was the outgrowth of the work of the Public Ownership League of America. It provides for a Federal Public Service Commission to supersede the present Federal Power Commission and for a bond issue of $500,000,000 as a revolving fund. When $500,000,000 has been expended the development will be financed permanently and the money returned to the revolving fund and another development begun. Concluding, General Tripp asked:

"If the public cannot trust its representatives to regulate a super-power system, how can it trust them to construct and operate it?"

Possible Power Projects on Arkansas River Outlined

Nineteen power projects are possible on Arkansas River in Colorado, according to a report prepared by an engineer of the Geological Survey. These projects will represent a total potential power of 44,000 hp. for 50 per cent of the time and 24,000 hp. for 90 per cent of the time.

The use of the water for power, however, is secondary to its use for irrigation. The total adjudicated and decreed water rights in three irrigation districts below Canon City amount to six times the mean annual flow at Canon City, but as the storage reservoirs for irrigation are in the lower part of the river, the natural flow in the upper part is available for the generation of electric power. The cost of developing power will be relatively high because of the low heads and the small flow and because the flow cannot be regulated for the generation of power owing to the requirements for irrigation.

A manuscript copy of the report, which describes more fully the power possibilities of Arkansas River above Canon City, Colo., may be consulted at the office of the Geological Survey at Washington, D. C., or at the district office of the Survey at Denver, 403 Federal Bldg. A copy of the report will be sent to other district offices of the Geological Survey for consultation on application to the Director, Geological Survey, Washington, D. C.

Boulder, Colo., Station Not Ready Before November

The Lakeside steam plant of the Public Service Company of Colorado will not be placed in operation before Nov. 1, according to recent announcements of the utility company. It was originally planned to place the plant, which is ultimately to cost $12,000,000, in operation about July 1 of this year, but delay in the arrival of machinery has held up the work so that it will not be possible to complete the project on the original date. The first unit, now under construction, will cost $4,000,000 and is to have a capacity of approximately 20,000 kw. The plant is at Boulder Lake, an artificial reservoir high in the mountains four miles east of Boulder.

Longest Transmission Spans Planned by Tacoma

The City of Tacoma, Wash., is planning the installation of the longest transmission-line spans in the world. There will be two of these spans, which are 6,153 ft. long and form part of the Cushman Power Project being built by the city. This project is located about 50 miles from Tacoma on the Skokomish River where an initial development of 36,000 kw. is contemplated. Other notable transmission-line spans on the North American Continent are: Two across Carquinez Straits on San Francisco Bay, Calif., 4,427 ft. and 4,753 ft. long respectively; one over the St. Lawrence River near Three Rivers, Quebec., Canada, 4,801 ft. long; and one over the Little Tennessee River in North Carolina, 5,010 ft. long.

Carnegie Steel Co. Orders New Equipment

The Carnegie Steel Co. has recently ordered of the Westinghouse company a million dollars' worth of electrical equipment to be used in a new structural mill which will be erected by the steel company at its Homestead works. This equipment includes a 15,000-kw. turbine-generator; three, 1,000-kw. 500 r.p.m. three-phase 25-cycle 6,600-volt a.c. motor-generators with their switchboards; and complete equipment for one 44-in. reversing blooming mill, one 36-in. reversing roughing mill and one 28-32-in. finishing mill.

The turbine-generator, which is to be installed in the main power house, will supply current for the new electrical equipment through a substation in the new mill.

New York Interlinking Its Power Systems

While the officials at Washington are occupied in planning an American superpower system and the policy of New York State is undefined as to power development, a movement is rapidly being consummated, consistent with the demand of commercial needs, to gradually link into one superpower system all the principal companies supplying electricity in the State of New York.

A link of considerable importance in this chain will be forged when the present plans of the Northern New York Utilities, Inc., of Watertown, are realized. This corporation, organized primarily to serve the inhabitants of the Black River watershed west of the Adirondacks now generates or distributes current in six counties. It has recently acquired the property and facilities of the Rome Gas & Electric Co. and is extending its system to where a physical connection with the Adirondack Power & Light Co. would be possible.

The Watertown company is to expend some $1,400,000 in improvements and extensions, the most important of which is the connecting up at Altmar, Oswego County, with the lines of the Niagara, Lockport & Ontario Power Co., thus affording an interchange of Niagara and northern New York developed current.

Simultaneously with the development by the Northern New York Utilities, Inc., the Canton Electric Light & Power Co., (St. Lawrence County) has increased its capital from $38,000 to $150,000 and the St. Lawrence Transmission Co. and the Oswegatchie Light & Power Co. are seeking permission of the Public Service Commission to construct large modern electric generating plants in the town of Gouverneur on the Oswegatchie River.

Within the last few months the St. Lawrence County Utilities, Inc., has been formed, which is a combination of the Massena Electric Light & Power Co., the Potsdam Electric Light & Power Co., the Ogdensburg Power & Light Co. and the Ogdensburg Gas Co. This corporation acts as the distributing company for the St. Lawrence Valley Power Co., which is composed of the recently combined St. Lawrence River Power Co. and the Hannawa Falls Power Co.

Canadian Water-Power Development Extended

Legislation has been enacted providing $950,000 to insure the execution of the works connected with the storing of the waters of Lake Kenogami and its tributary lakes and rivers. This is in addition to the $1,800,000 authorized some time ago. It is hoped that as a result of this development paper mills in the district can be operated the whole year round. A bill has also been passed granting $500,000 additional for work in connection with the great Gouin Dam at La Loutre, according to government reports.

St. Lawrence River Dam Proposed

Stating that the diversion of water from the Great Lakes by the Chicago Drainage Canal has changed the character of the problem of maintaining an adequate channel for ocean-going ships in the St. Lawrence below Montreal, Col. W. I. Gear, president of the Canadian Shipping Federation, now proposes the construction of a dam across the St. Lawrence between Champlain and Cape Rouge, about halfway between Montreal and Quebec. Such a dam, he says, should be high enough to give a depth of 37 or 40 ft. in the ship channel, and in it there should be two locks over 1,000 ft. in length for ocean-going vessels and two smaller locks for river craft.

The Shipping Federation believes that the proposed dam could be built for less than the cost of dredging a 35-ft. ship channel which was the plan of the Canadian government. The dam would be utilized to develop hydropower, and would have to be of a massive character to withstand the the movement of ice in the spring, according to press reports.

Shall the Klamath River Be Devoted to Fish or Power?

An effort to hold out of use the entire power potentialities of the Klamath River is being made by fish interests in California. A determined effort is afoot to make of this stream a permanent fish preserve.

Eventually, no less than 1,000,000 hp. can be developed on this stream. At the present time two applications for rights on this stream are before the Federal Power Commission. One was made by the Electrometals Co. and the other by A. P. Seybold.

Petitions are being circulated to secure the signatures necessary for an initiative measure which would be voted on in November.

In this connection it is predicted that California will be in urgent need of Klamath River power within fifteen years. The need might occur at an earlier date were there any rapid slump in petroleum production.

This activity is being cited as typical of the fish industry to fight the producers of power rather than attempting to co-operate with them.

Oil Burners for Philadelphia City Hall

The City of Philadelphia has recently placed an order for equipping its City Hall power plant with Bethlehem-Dahl fuel-oil burning equipment. This consists of complete equipment for two firerooms and makes the entire power plant of the City Hall oil burning.

Columbia Changes Courses from Six to Four Years

Those interested in the improvement of engineering education will regret to hear that the faculty of Columbia University has abolished the six-year courses in civil, mechanical, mining and chemical engineering, which were instituted several years ago, for the four-year undergraduate course with bachelor's degree and an additional year for the engineer's degree for such as care to pursue the course.

Many engineers interested in the advancement of the engineering profession feel that this is a step backward as six-year men are better trained and worth more to the industry.

Hydro Plant for California-Oregon Power Co.

The California Oregon Power Co. has applied to the California Railroad Commission for an order approving an agreement with the Pacific Gas & Electric Co. for the construction of Copco No. 2 plant on the Klamath River in northern California, a transmission line from the plant to Delta, Calif., and for the sale of the output of the plant to the Pacific Gas & Electric Co. The plant would be a duplicate of the Copco No. 1 and located about a mile downstream from it. Plans call for the installation of one 25,000-kw. generator with hydraulic turbine and for the completion of the plant by April, 1925.

Wonderful Tours To Be Taken After Power Conference

The delegates and members of the First World Power Conference, June 30 to July 12, will have the opportunity of making some tours after the conference under the direction of the British, French, Italian, Swiss, Swedish and Norwegian National Committees.

A well-illustrated booklet describing these tours with the itinerary, and information in regard to passports, visas, accommodations and other important subjects has been put out for the convenience of those who desire to make these tours by the committee. Information in regard to tours can be had from Thomas Cook & Sons, 585 Fifth Ave., New York City.

The tours that are scheduled include: Great Britain, beginning July 15; France, Switzerland and Italy, July 14; Scandinavia, including Lapland, July 15. They should not only be most comfortable, but as they are being conducted under the direction of the National Committee of the countries visited, the visitor will be able to see the power projects and great beauties of the countries under exceptional conditions.

Cumberland River Project Gets Permit

A preliminary permit was issued by the Federal Power Commission to the Cumberland Hydro-electric Power Co. of Frankfort, Ky.

The preliminary permit covers two proposed power dams in the Cumberland River between Burnside and Williamsburg, Ky., and a third dam in the South Fork of the Cumberland River at a point near Burnside.

When this application was filed, it was in conflict with the proposed project of the city of Louisville. This application, however, was rejected last year. Three projects will develop 200,000 hp., it is estimated, but it is probable that the immediate installation will not exceed 150,000 hp. Because of the wide variation in the flow of the Cumberland, the engineers of the Federal Power Commission held that the project could be developed only by a company having a large interconnected system and a steam reserve equal to or greater than the capacity of the water-power plants.

The preliminary permit contains the condition that the power company is to design its dams so as to permit construction of locks at a later date if found desirable. In that event, the cost of the locks will be borne by the United States.

Fire-Fighting Equipment for Generators

The final form of the recommendation for fire-fighting equipment on electric generators, as made by the National Electric Light Association, are as follows:

1. All turbo-generators of the horizontal air-cooled type, regardless of size, to be provided with openings in the outer casings, such openings to be covered by quickly removable plates through which quickly accessible hose streams can be injected into the windings.

2. Where space between the outer casings and the windings is sufficient, a suitable apparatus should be permanently installed for extinguishing generator fires. This equipment may be of (a) internal water or steam spray type, or (b) the type using steam application in the air duct below the generator, or (c) the type using a satisfactory inert gas. Any type using steam should be designed to avoid high temperature steam impinging directly on the windings. All systems should be connected to a constant source of extinguishing medium and arranged for quick application. Care should be taken to prevent water or steam leaking into the generator by installing proper valves and drip.

3. When conditions will permit, a well-designed balanced relay system should be provided which will electrically disconnect the generator from service.

4. Means should be provided for closing dampers in the air ducts when such procedure is favorable, although recognizing the fact that there can be no guarantee against leakage around the dampers.

Two Diesel Engines for Fredonia, Kansas

Contracts for two 300-hp. Diesel-engine generating units, switchboard and installation were awarded to the Worthington Pump & Machinery Co., Kansas City, Mo., by the Fredonia (Kansas) Electric Light & Distribution System, for $61,375.

Diesel Pumping-Station Costs

In a paper read before the Annual Convention of the American Water Works Association, New York, May 23, P. deW. Vosburg gave a brief account of the installation and operation of the Gloucester, N. J., water plant. Formerly a steam-driven plant was in use, but by reason of increased demand either a new plant or extensive additions were necessary. Since the cost of operating the old plant was excessive, a new station was designed.

Motor-driven centrifugal pumps lift the water from a series of wells into a settling basin, out of which the water is put into the service mains by motor-driven single-stage centrifugal pumps. Two 180-hp. Diesel engines were installed direct connected to generators, to supply the power. The guarantee of the maker was 0.48 lb. of fuel per brake horsepower, but in actual service the engine used less, requiring 0.0624 gal. per horsepower-hour, while the lubricating-oil consumption is 0.66 gal. per 1,000 hp.-hr. In 1923, while pumping 2,900,000 gal. daily, the cost per 1,000 gal. of water pumped was 1 cent operating expense and 2 cents overhead. The new plant cost $110,500 and overhead is based on 5 per cent interest and 4 per cent depreciation. The saving per year over the steam plant is $36,000.

Switzerland Gains 60,000 Hp. in 1923

The utilization of water power in Switzerland at the close of 1923 had reached a total of 1,500,000 hp., as compared with 1,440,000 at the close of 1922. This represents an increase during the year of 60,000 hp., which is mainly accounted for by the construction of the power station at the Barberine Falls near Martigny in the Rhone Valley, where 46,800 hp. was provided for. The remainder was made up by small extensions of the Wynau station (an increase of 4,400) and of the Olten-Goesgen (8,500). It is intended to increase the production at the Barberine to 78,000 hp., while the Wynau station will provide still another 4,400.

In addition to these increases four new power stations were already under construction at the end of the year, namely: Chancy-Pougny, 43,865 hp.; Waggital, 140,000 hp.; Tourtemagne, 23,000 hp., and Davos-Klosters, 30,000 hp. The total of these four, together with the addition of Vernayaz, which will complete the Barberine station, gives about 330,000 hp., so that the production of stations in use and under construction at the close of last year amounted to 1,830,000.

The utilizable water power in Switzerland is estimated at a minimum of 3,000,000 hp. and at a maximum of 8,000,000 hp., so that there remains a great deal more to be captured, according to the *Christian Science Monitor.*

Coal Output of Great Britain and United States

At a recent meeting of D. Davis & Sons, London, Sir David Llewellyn, prominent in the Welsh coal industry, stated, in reference to coal output, that "the relative position of the United States and the United Kingdom in total output and the output per person employed may be gathered from the fact that the approximate output of the United States in 1923 amounted to 590,000,000 tons or 958 tons per person employed, while the United Kingdom produced but 278,500,000 tons or 239 tons per person employed," according to Special Circular No. 31, United States Department of Commerce.

Hydro Plant for Western Mexico

San Francisco capital is interested in a hydro-electric project in western Mexico, which is said to be capable of developing more than 150,000 hp. and may mark a new era in the development of that section of the Southern republic. The Sierra Madre Power Co. has been incorporated in Mexico to carry out the plan, which includes damming the Rio Verde, in the State of Sinaloa. The dam will be 230 ft. high and will create a reservoir approximately 7 miles long and 2 miles wide at its widest part. At a point 1,700 ft. below the dam the power plant will be constructed with an initial capacity of 15,000 hp. The cities of Mazatlan and Cullacan and the numerous mines in the district are relied on for a market.

African Power Projects Being Considered

The press reports large schemes for extension of hydro-electric power are at present under urgent consideration in widely separated parts of Africa. The most urgent question of all is in the Belgian Congo. After detailed investigation by various committees the government has decided in theory on electrification, estimated to cost 50,000,000 france and to be started at an early date. The power will be derived from the cataracts and will be used for both the electrification of the railways and for local industries.

In French Morocco, the rivers which drain the Atlas Mountains are to be utilized for power purposes. In a report just presented to the government, a far-reaching plan is recommended by which, at no excessive cost, the present and future railways, the local industries, municipal lighting and irrigation could be supplied.

Mexican petroleum exports for March aggregated 13,330,000 bbl.—1,500,000 more than the February exports, and a total greater than that of any month since October, 1922, according to *Commerce Reports.*

New Heating Plant for East Springfield

A new heating plant for the East Springfield works has been announced by the Westinghouse Electric & Manufacturing Co. It will contain four 5,000-sq.ft. B. & W. boilers and will be equipped with the newest type of Westinghouse stokers also with coal- and ash-handling machinery. It is estimated that 5,000 tons of coal a year will be used by this plant.

Great Western Completes Storage Dam

The main section and spillway of the Butte Valley dam, in Plumas County, Calif., was recently completed by the Great Western Power Co. of San Francisco. The dam, which is of the hydraulic-fill type, will increase the storage in Butte Valley from 5,000 acre-feet to 50,000 acre feet and will provide an additional water supply for the Caribou plant on the American River. An additional generating unit of 25,000 kw. capacity was placed in operation in this plant April 1, bringing the total capacity of the plant up to 72,000 kw. The water impounded by the new dam, with that stored in Lake Almonor, gives the company a total storage of 350,000 acre-feet in the two reservoirs for its two hydro-electric plants in this section. Lake Almonor is capable of an ultimate storage of 1,250,000 acre-feet, which will be developed as the demands for power increase on the Great Western system.

Menai Straits Tide Power for Wales

The North Wales correspondent of the *Manchester Guardian* gives the outline of an electric generating scheme to obtain power from the rise and fall of the tides at the Menai Straits in the same way as it is proposed to do on the Severn. A scheme to build a barrage in the Menai Straits for this purpose has been sent to the Ministry of Transport by H. J. Jack, the managing director of the North Wales Power Co.

The Severn plan, says Mr. Jack, is estimated to cost about £30,000,000, the chief expense being the building of storage reservoirs to supply power during the slack period of the tides. If the enormous amount of energy that can be produced is to be used, it will mean its transmission not only to South Wales, but to London and the Midlands also. But Mr. Jack contends that a barrage and power station at the Menai Straits could co-operate with the Severn barrage to nullify the difficulty of the slack tide period owing to the difference in the tide times at the two places. In addition, the work at Menai might be combined with the new bridge that is contemplated by making a causeway for a road on the barrage dam, with a lock for shipping.

If the energy developed proves, as is probable, to be greater than can be used in conjunction with the high level storages of the Aluminum Corp. which are now under construction, this surplus could be used by transmitting it to the Midlands and then connecting it with the Severn system.

Power from the Lignite of Saskatchewan Fields

In a recent address before the Saskatchewan Branch of the Engineering Institute of Canada, J. B. Hamilton, superintendent of public utilities of the town of Estevan, drew attention to the advantages of developing the large fields of lignite in this province. The province of Ontario in 1922 imported 1,640,000 tons of anthracite and 9,440,000 tons of bituminous coal.

The utilization of Saskatchewan lignite on the principle of carbonizing the coal and using the excess gases and by-products would be the beginning of a solution to the fuel shortage in Ontario. As Saskatchewan becomes a more populated and manufacturing province, the amount of byproduct carbonized fuel available for shipment to Ontario will decrease the imports and simultaneously decrease the trade deficit of the national balance sheet.

Coal imported into Canada from 1912 to 1921 exceeded the sum of $580,000,000. The lignite fields have a known deposit of 2,412,000,000 tons, and at the present rate of consumption it would be sufficient for 6,030 years. There is an estimated deposit of 57,000,000,000 tons which, at the present rate, would last for 142,500 years.

At the present time there is a total investment within a radius of ten miles of Estevan of about $2,000,000. This has been invested in the hope that Saskatchewan would make use of her resources of coal. Taxes are being paid and employment provided during the winter, giving a surplus of men for the farms during the summer, with the ability to supply, as average daily output, 3,750 tons of coal per day all the year round. The amount of coal available in six mines is 151,738,754 tons.

Much of this mining is known as "stripping." Coal can be picked up from the surface with a steam shovel, and with the aid of two men four tons are loaded per minute. It is also necessary to work seams, one of which has an average of 96 in. in height, allowing for floor and roof losses.

It appears that with such a small amount of population, central station plants would not be effective. This, however, is not an argument against the necessity of an investigation into the possibilities of a central plant and a more comprehensive and co-ordinated development of power for southern Saskatchewan. The figures for the power developed in 1921 are given in the table.

MUNICIPAL STATIONS GENERATE NEARLY ALL OF CANADA'S POWER

Total for province:	
Total generated, kw.-hr.	54,295,000
Per cent of total for Canada	0.97
Kilovolt-ampere capacity	43,595
Average kilowatts per kva. capacity	1,245
Total Municipal Stations:	
Total generated, kw.-hr.	53,566,000
Kilovolt-ampere	42,592
Average kw. per kva.	1,248

The total number of tons of coal required for municipal plants is 153,040. This assumes an average for the Province of 20 lb. of water per kilowatt with an evaporation of 3.5. The load factor for municipal plants was 14.3 per cent. About 8,000 hp. is developed every twenty-four hour for 365 days.

The utilization of lignite entirely for power would represent a saving in freight rates on anthracite and bituminous coal and coke, of about twice the value of this imported fuel. It is estimated that in 1921, 120,087 tons of fuel was used, of which 90,882 tons was lignite, the remainder, 29,105, costing at mines, $186,135. The saving in freight rates on this coal would amount, however, to about $318,137.

Central-station power should be considered on account of high over-all economy; centralizing the operation of coal handling would be an advantage with this type of fuel. At the present time twelve operations are required in supplying coal to the private bin: (1) Coal is mined; (2) loaded on one or two-ton cars; (3) hauled to shaft; (4) hoisted; (5) tipped on to screens; (6) screened; (7) empty car shunted to position; (8) loaded into car; (9) full car shunted; (10) hauled to destination; (11) shunted to respective siding suitable to buyer and, (12) unloaded or hoisted to private bin. By the proper selection of coal land and equipment this could be reduced to three—stripping, loading and hauling to bunkers. Three operations for generating electricity from coal are here considered; namely, the usual method of firing lignite directly, second, by means of suction power gas-producer systems, and third, by the carbonization of the fuel. The sale of byproducts in the last two cases is carefully analyzed.

With suction gas-producer system, as based on data from the United States Bureau of Mines, the actual cost per horsepower-hour would be 0.1c. net. This gives credit for byproducts at the rate of 0.064c. per hp.-hr. By the method of carbonization and use of surplus gas also based on analysis of the Bureau of Mines, the cost per horsepower-hour would be 0.08c. In this case the byproduct per horsepower-hour is estimated at 1.05c. This includes the price of $3 per ton for selling char.

Grand Falls Power Project To Be Developed

Premier P. J. Veniot of the Province of New Brunswick, Canada, has announced that the provincial government will undertake the development of the power site at Grand Falls on the St. John River. Harry G. Acres, hydraulic engineer of the Ontario Hydro-Electric Power Commission, recently made a report to the New Brunswick Provincial Government on the power possibilities of this site in which he stated that the ultimate capacity would be from 120,000 to 140,000 hp., but that as the St. John River is international in character and as the greater part of the area available for storage reservoirs lies within the State of Maine, the storage available in Canada would provide only from 60,000 to 80,000 hp.

According to Premier Veniot's statement, the provincial government will not undertake actual construction until the co-operation of the United States Government has been secured.

Stevens' Commencement June 14-17

Stevens Institute of Technology, Hoboken, N. J., will hold its graduation exercises from June 14 to 17 and the Sixteenth Annual Alumni Day will be on June 14, at Castle Point. A luncheon will be given in the Lackawanna dining room followed by exercises in the afternoon in the auditorium of the administration building. This will be followed by a parade, after which supper will be served on the lawn.

Diesel Engines for Shipping Board Vessels Certain

The expenditure of $25,000,000 on the Dieselization of Shipping Board vessels has been assured by the passage of legislation to that effect by the Senate. The bill previously had been approved by the House. The President's signature is certain to be forthcoming. The equipping of these ships with internal-combustion engines is expected to make them readily salable, or at least to make them attractive to operators on a leasing basis.

French to Make Mercury Boilers

Following in the steps of the American application of mercury vapor as replacing steam, a French company has just been organized to work the process in France. The company is known as the Société Hewittic, a filial of the Hewettic Electric Co., Ltd. Capital is but 500,000 francs in shares of 500 francs each, of which 450 shares of the capital, rather less than half, in conformity with recent French law, are attributed to the British company. The Administrateur-Délegué of the French company is Albert Widmer, engineer of arts and manufactures at Paris.

Smith Warns Against Oil Wasting

At the annual banquet of the Massachusetts State Chamber of Commerce held at Worcester on May 21, George Otis Smith, Director of the United States Geological Survey, spoke with earnestness in regard to unbusinesslike handling of our national oil policy. He said in part:

"Petroleum is plainly a wasting asset. Since 1908, when public attention was first called to the need of conserving some of the publicly owned oil lands to meet the future needs of the government itself, the per capita consumption of petroleum and its products has more than trebled. The way the American oil industry met the war demand for oil merited our outspoken admiration, but already the peace demand for oil has far overtopped the war peak. The rate at which we are now depleting our oil resources may be inferred from the fact that last year our wells poured forth one-tenth of all the oil produced in the country to date, and furthermore, authoritative estimates by geologists indicate that the original supply is more than 40 per cent gone. Plainly, serious planning for the future cannot longer be delayed, and no short-sighted policy in oil can serve the United States.

"For a year now the naval oil reserves have been much in the public eye and the political and personal phases of the problems connected with them have been discussed and debated until the public interest has begun to flag—if indeed, the real issue was not lost sight of long ago. A few weeks ago, however, President Coolidge reminded the country that the original purpose in setting aside the naval oil lands was to provide reserves of oil for the future needs of the Navy. The President characterized this oil in the ground as 'an important part of the national insurance.'

"In his reference to naval oil as national insurance, I take it the President meant long-term insurance, not an endowment policy to be cashed in whenever there seemed to be need of funds. It was this failure to distinguish between the temporary and current needs of the Navy and its future emergency requirements that brought about the unbusinesslike handling of these reserves. Oil which the plans made in the Taft administration intended to retain in the ground as far as possible and until urgent need arose, had more recently been disposed of for one reason or another. Of course I speak as a geologist who has been interested in these reserves ever since the inception of the naval oil policy and not in my present capacity as a member of the President's Commission, which speaks for itself in its reports to the President. As a geologist I have thus far failed to see any geological warrant whatever for leases as extensive or long-termed as those which are now in litigation. Indeed, knowing all the facts as shown in the record and on the ground, the friend of naval oil reserves is forced to believe that for the conservation policy of keeping the oil in the ground was substituted an exploitation policy of letting the oil flow like money.

"It is this use of reserved oil as legal tender that puts the severest strain on our confidence. Why should anyone propose for the sake of a small present advantage to compromise the future? A time when oil is plentiful and cheap is hardly an opportune time to give oil in exchange for the services and material needed in harbor improvement, tank construction and oil transportation. 'Without any cash outlay by the United States' was the formula used in exchanging oil at a low price level for steel tanks at a high price level. However, everyone in touch with the oil industry expects higher prices, and moreover, the future possession of the Navy's oil in the ground will constitute much more than an economic advantage, for the time is not far distant when a shortage will follow plenty. The purpose of these naval oil reserves being national security, any present-day disposition of this oil is like selling a birthright for a mess of tankage.

"This future emergency supply which the naval reserves were planned to afford was never regarded as excessive, if indeed it was even adequate, in view of the increase in number of oil-burning vessels in the Navy. So the reported danger that the reserved oil would be drained off through neighboring wells caused concern and demanded action, but the line of action decided upon was to drain the oil through wells on the Navy lands—a getting and spending policy rather than a protecting and saving policy. Yet, of the oil thus taken from the naval reserves, only a mere pittance was to be put into Navy tanks. In other words, the suspected and expected migration of oil across the boundary lines of the Elk Hills and Teapot Dome reserves—though the extent of the loss was debatable—was made the basis for throwing the whole property open to drilling, the corporations, which were to do the work and take the risks of oil production, being paid in oil; moreover, to these oil companies were awarded construction contracts, for which again payment was to be made in oil. This free coinage of oil suggests to me the bartering methods of an unfortunate Yankee who had more land than money rather than a business transaction by the richest government of the world, which possessed too large gold reserves and too small oil reserves. The outstanding fact is that however urgent may have been the need for action and however good bargains the leases may seem to have been, payment for services and material was made with oil that the earlier policy of our government had intended to reserve for use as naval fuel.

"In the name of good business, the Navy's oil has been 'saved' by spending 92 barrels out of every 100 barrels extracted from the California reserves in order to put less than 8 barrels into storage. That kind of liquidation of an irreplaceable asset must suggest to you business men only the desperate effort of a landowner facing bankruptcy, surely not the deliberate policy of a great nation planning for a long future.

Maps of Superpower Survey Ready July 1

THE seventeen plates that have been prepared by the Federal Power Commission in connection with the superpower negotiations being conducted by Commerce Secretary Hoover are now in the hands of the lithographers. Copies will not be available for distribution, however, until July 1.

The maps and curves will be accompanied by a short text, setting forth the findings and conclusions of the engineers who assembled the data. The growth of population and of power consumption in each of the fifteen states covered and for the entire eastern-northeastern area will be shown. Generating capacity, power loads, hydro-electric possibilities, transmission lines and coal deposits will be shown.

The information that will be set forth in these lithographs will be of particular value to everyone interested in power since it concentrates in graphic form information from several federal agencies and from the states included in this survey.

The fifteen states included produce half the country's output of power.

"However, this policy of doing things 'without cash outlay' was not adopted without some indirect help from the legislative branch of our government, which therefore must share the blame. Economies carried to excess in the making of budgets and appropriations tend to force the executive officers, who are held responsible for results even if they are given little authority and less money, to construe statutes rather broadly and to use any means at hand that they believe justified by national ends. Moreover, if, as the President's Commission on Oil Reserves has declared, the choice between oil and dollars has to be made, obviously Congress alone has the power to choose. Secretary Denby, in seeking to have a Navy fully prepared, possibly thought that he had no choice—that if the Navy was to have storage at Pearl Harbor, naval oil must meet the bills.

"So, looking ahead rather than back, if we are to adopt a naval oil policy that will violate neither moral nor economic sensibilities and yet will meet the strategic needs of our Navy, we must have co-operative effort by the executive and the legislative branches of the government. It would seem both obvious and constitutional that neither branch has the right to disregard the other, but that both should be responsive to a popular demand for a businesslike policy. Not more business in government, unless it is better business!"

Hoover's Advice To Buy Now Not Welcome to Dealers

Recently, Mr. Hoover addressed a letter to the secretaries of trade associations asking their support in urging manufacturers to begin buying and storing coal now in order to avert car shortage and transportation congestion next autumn.

An unusual situation in the coal trade is revealed by the reaction to Secretary Hoover's advice to buy now. Many of the producers of coal are not at all enthusiastic about Mr. Hoover's message and wish that he had kept his mouth shut. The operators who hold this opinion believe they will be better off at the end of next winter if the consumers are allowed to go ahead, just as they are doing, and use up their stocks. This will mean that they will come rushing into the market this fall with the probability that the operators who can afford to wait will profit much more than would have been the case had the buying been spread evenly over the summer.

A few consumers already have recognized that the hand they can play to greatest advantage is not to draw on stocks now, but to continue buying their current requirements in the existing easy market and then use their stocks when prices go up in the fall or winter. Much interest is being manifested in the result of Secretary Hoover's letter. The more generally held view is that most consumers will not be able to resist the temptation of coasting on their stocks. Some think, however, that the consumers have been convinced that storage is greatly in their interest and that buying will begin, once that stocks are reduced to forty million tons.

Northern Illinois Gets Coffin Award

The Public Service Co. of Northern Illinois was the recipient on May 21 at Atlantic City, of the Charles A. Coffin Award for 1923. This award is made each year at the N.E.L.A. annual convention to the company which during the year made the "greatest contribution toward increasing the advantages of the use of electric light and power for the convenience and well-being of the public and the benefit of the industry." The award was established in 1922 by the Charles A. Coffin Foundation.

Boiler Manufacturers' Meeting June 9-11

The American Boiler Manufacturers' Association will have on the program of its meeting, which is to be held at The Homestead, Hot Springs, Va., June 9-11, several addresses of interest to readers of *Power:*

Tuesday, June 10—Address by Joseph F. Scott, president of the National Board of Boiler and Pressure Vessels Inspectors; Address by C. O. Myers, secy-tres. National Board of Boiler and Pressure Vessels Inspectors; Address by Charles E. Gorton, chairman, Administrative Council, American Uniform Boiler Law Society; Address by R. M. Hudson, Department of Commerce, on "Simplification," illustrated by lantern slides.

Colorado Springs Votes for Municipal Plant

After a vigorously waged contest which culminated in the heaviest vote ever cast in a special election involving a bond issue in Colorado Springs, that city voted on Tuesday, May 20, to authorize an issue of $1,250,000 to erect, purchase or equip a municipal light and power plant. The vote stood: For the issue, 3,178; against the issue. 2,294, giving the issue a majority of 884.

Since the refusal of a new franchise to the Colorado Springs Light, Heat & Power Co., which has operated in Colorado Springs for a number of years, the fight has been a bitter one, and toward the end the municipal ownership issue itself was largely lost sight of, and it became more a question of politics and personalities. It is not yet determined whether the city will build its own plant or try to purchase that of the company.

Priest Rapids Project Held Up by Fish

A declaration by Henry J. O'Malley, head of the United States Bureau of Fisheries, that the federal government would be compelled to recognize the rights of the fishery interests as prior to the rights of the applicants for power was made at a public hearing in Seattle on May 14 held by the state fish commissions of Oregon and Washington to consider the application of the Washington Irrigation & Development Co. for a permit to construct a dam across the Columbia River at Priest Rapids to be 90 ft. high.

Mr. O'Malley told the power interests that the government would require them to prove conclusively that a fishway or fishways could be constructed that would permit salmon to pass over the big dam on their way to and from upper river spawning grounds before the Federal Power Commission would grant the license requested. He concluded his statement by asserting that up to this time, so far as the Bureau of Fisheries was informed, no fishway had been constructed that solved the problem of taking salmon over a dam more than 40 ft. high.

Canada To Make Fuel Compound

A company plans to start operations shortly in Hamilton, Ont., known as the J. P. Porter Co. This concern is organized to manufacture a patent fuel from coal screenings and asphaltic fuel oil. A five-acre site has been leased from the Canadian National Railway. From $100,000 to $150,000 will be spent on a plant which at the outset will give employment to forty to fifty persons. J. P. Porter, one of the contractors on the Welland Canal, and H. L. Ferry, of the Ferry Coal Co., Hamilton, are associated in the formation of the company.

New Steam Plant for Utica Gas & Electric Co.

The Utica Gas & Electric Co. has recently placed an order with the Westinghouse company for two 15,000-kw. three-phase 60-cycle turbine generator units, with switching equipment, as the initial installation in a new steam plant being built by the power company and designed for an ultimate capacity of 90,000 to 100,000 kw.

The company use hydro-electric power for the most part, developed from the Adirondack Mountain streams, and the new steam plant will be used as a stand-by to the hydro-electric stations, operating probably only part of the year. The turbines for the steam plant are to be of the latest design Westinghouse combination impulse - reaction type, capable of developing 15,000 kw. and designed to operate with 275 lb. steam pressure at the throttle, 125 deg. superheat and 28½-in. vacuum. The generators are 18,750 kva. 15,000 kw. at 80 per cent power factor and are for 3 phase, 60 cycle, 13,800 volt service. The units will operate at 1,800 r.p.m.

Water-Power Projects

Ireland Hydro-Electric Possibilities.—The Free State Government of Ireland has entered into an agreement with an engineering concern for a comprehensive survey of the hydro-electric possibilities of the River Shannon. A detailed scheme is to be worked out for harnessing the Shannon and for the distribution of power over the 26 counties of the Free State. If the findings are favorable, the government may develop the project as a state enterprise, according to Vice Consul Harold M. Collins, Dublin.

California Projects.—Two permits covering power sites in Nevada and

Placer Counties, California, have been issued to the Pacific Gas & Electric Co. by the California Department of Public Works. One permit allows the appropriation of 26,670 acre-feet per year from Fordyce Creek in Nevada County for the purpose of developing 17,170 hp. After the water is passed through the company's power house it will be used for irrigating purposes. The estimated cost is $745,500. The second permit is to develop 8,693 hp. by utilizing 100 sec.-ft. of water from the Bear River.

E. B. Perrin, Los Angeles, has filed two applications covering projects in Tehama County. One of these is for 50 sec.-ft. and 12,000 acre-ft. of water from Thoms Creek and the other is for 150 sec.-ft. and 20,000 acre-ft. from the same source. The first project contemplates the generation of 5,823 hp. and the second a development of 27,272 hp.

The Bear River Water & Power Co., Auburn, contemplates the development of 42,994 hp. by diverting 250 sec.-ft. and 100,000 acre-ft. per year from the Bear River in Placer and Nevada Counties.

The Feather River Power Co., San Francisco, has filed three applications for water—from Gold Lake in Sierra and Placer Counties, from Bucks Creek in Plumas County and from Grizzly Creek in Plumas County. All three applications are supplementary to the company's original application.

The development of 24,148 hp. is contemplated by G. de Bretteville, San Francisco. It is the applicant's intention to divert 250 sec.-ft. and 30,000 acre-ft. of water per year from the Middle Fork of the Yuba River in Yuba and Nevada Counties. The estimated cost of the project is $3,500,000.

Society Affairs

The Detroit Engineering Society will have as the attraction for its June 20 or Spring meeting a talk by C. Harold Berry on the "Detroit Edison Company's Trenton Channel Plant."

The American Engineering Standards Committee, 29 West 39th St., New York City announces a conference on standardization of cast-iron pipes, to be held in room 1101, 29 West 39th St., New York City, on June 5, at 10:30 a.m.

The Michigan Engineering Society, at its annual state convention held at Port Huron, Feb. 5-7, elected the following officers: H. A. Shuptrine, president; H. Bouchard, vice-president; H. L. Hudon, treasurer; George M. Ames, director-at-large.

The American Marine Standards Committee has adopted an expanded program calling for surveys covering numbers of items: Pipings; pipe flanges; lubrication; gages (pressure and vacuum), thermometers; firebrick and refractory cement; care and operation of Diesel machinery.

The American Society of Civil Engineers will hold its fifty-fourth annual convention this year at the Maryland Hotel, Pasadena, Calif., June 18-20. One of the important subjects under discussion will be the Colorado River problem. William Kelly, of the Corps of Engineers and Federal Power Commission, will give an address and a discussion will follow.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, June 11-13.

American Boiler Manufacturers' Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Annual meeting at the "Homestead," Hot Springs, Va. June 9-11.

The American Institute of Chemical Engineers. Dr. John C. Olsen, Polytechnic Institute of Brooklyn, New York. Summer meeting in Denver, July 16-19.

American Institute of Electrical Engineers. F. L. Hutchinson, 33 West 39th St., New York City. Annual convention, Edgewater Beach, Chicago, Ill., June 23-27.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44th St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 9-13.

American Society of Civil Engineers. J. H. Dunlap, 33 West 39th St., New York City. Convention, Pasadena, Calif., June 18-20.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Kansas City, Mo., June 10-12.

American Society for Testing Materials. C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 23-28.

Canadian Association of Sationary Engineers. Gordon C. Keith, 51 Wellington St., West Toronto, Ont. Annual meeting, St. Thomas, Ont., June 24-26.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Illinois Association** at Rockford, Ill., June 4-6. L. G. Schlemm, 805½ South Ninth St., Springfield, Ill. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **New York State** at Niagara Falls, June 13-14. William Adelyotte, Shredded Wheat Co., Niagara Falls. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at Bridgeport. June 27-28. George F. Klopfer, 30 East Pearl St., New Haven, Conn. **New England States Association** at Cambridge, Mass., July 10-12. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Minnesota Association at Faribault,** Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22nd Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12.

Smoke Prevention Association. Frank A. Chambers, 111 North Dearborn St., Chicago, Ill. Eighteenth annual convention at Hotel Statler, Buffalo, N. Y., June 3-5.

Society for the Promotion of Engineering Education. Charles F. Scott, University of Pittsburgh, Pittsburgh, Pa. Annual meeting, University of Colorado, Boulder, Colo., June 25-28.

Stoker Manufacturers Association. G. A. Sacchi, Westinghouse Elec. & Manufacturing Co., Philadelphia, Pa. Annual meeting at Edgewater Beach Hotel, Chicago, Ill., June 2-4.

Western Society of Engineers. E. S. Nethercut, 1736 Monadnock Bldg., Chicago, Ill. Meeting at Chicago, June 4, 1924.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

Obituary

Stephen Olin Johnson, one of the founders of the Penberthy Injector Co., died on May 17 at the age of 76, in a sanitarium at Los Angeles. Mr. Johnson had been active in the business circles of Detroit for over forty years, thirty of which he had headed the company with which he was connected when he died. Born in Westfield, Mass., in 1847, he spent some time in New York City, and then went to Denver on account of his health, finally going to Detroit in 1884, where two years later he founded, with Homer Pennock and William Penberthy, the Penberthy Injector Co., of which his son, Charles B. Johnson, is treasurer. Mr. Johnson was buried in Detroit on May 24.

Business Notes

The Conveyors Corporation of America, 326 Madison St., Chicago, Ill., announces a change in the address of its eastern Canadian representative The Cleaton Company, Ltd., to 1070 Bleury St., Montreal, Quebec.

The Ingersoll-Rand Co., 11 Broadway, New York City, announces that L. D. Albin, general sales manager, has been elected vice-president in charge of European sales. D. C. Keefe has been appointed to succeed Mr. Albin as general sales manager.

The Diamond Specialty Corp., Detroit, Mich., manufacturer of soot blowers for water-tube and horizontal return-tubular boilers, has appointed W. L. Sullivan, 505 Central National Bank Bldg., Tulsa, Okla., as its representative for the State of Oklahoma.

The Cochrane Corporation is the new name adopted by the H. S. B. W.-Cochrane Corp., Philadelphia, Pa., formerly the Harrison Safety Boiler Works. The change has been made purely for the purpose of obtaining a shorter and more usuable name and implies no change in organization or line of heaters, etc.

The Elliott Company, Jeannette, Pa., announces some recent changes in its sales department. R. K. Williams, formerly of the Cleveland office, is now district sales manager of the Detroit office, taking the place of W. R. Danley who resigned. R. W. Fox, of the New York office, has been transferred to the Cleveland office.

The Ash Reclaiming Corp., 347 Madison Ave., New York City, announces that it has taken over the United States rights for the Schilde "Kolumbus" separator. This device, which was described in *Power* June 6, 1922, employs a fluid of specific gravity about 1.25 or 1.30. Its density can be easily controlled so that the coke in the ash floats on the surface, while the non-combustible clinker and ash sinks. The mechanism of the apparatus is very simple, and consists merely of a small tank to contain the fluid and two inclined screw conveyors .placed one over the other. The upper one catches and removes the floating coke, and the lower does the same for the heavier non-combustible.

Trade Catalogs

Pumps and Compressors—Century Electric Co., St. Louis, Mo. Leaflet describing pumps built in sizes of ⅛ to 40 hp.

Disks — The Johns-Pratt Co., 30 Church St., New York City. Leaflet "Always at Work," describes compressed asbestos valve disks.

Coal Versus Fuel Oil, Comparative Data—W. A. Marshall & Co., 25 Beaver St., New York City. This little pamphlet, Form 101, is a comparison of the fuels, as stated in the title, from the coal dealer's point of view.

Lubrication — McCord Radiator & Mfg. Co., Detroit, Mich. Bulletin "The Economy of Better Lubrication," contains descriptions and illustrations Class B. lubricator adapted to small steam, oil, gasoline engines, air compressors, pumps and auxiliaries.

Lubrication Refrigerating Plant — Vacuum Oil Co., New York City. This 62-page pamphlet takes up the entire subject of refrigerating-plant lubrication. It is clearly written and well illustrated with sectional drawings of compressors and other machinery used for refrigeration.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	May 19, 1924	May 26, 1924
Pool 1	New York	$3.00	$2.85
Smokeless	Columbus	2.35	2.40
Clearfield	Boston	2.40	2.35
Somerset	Boston	2.50	2.50
Kanawha	Columbus	....	....
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.85	1.75
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—May 28, light oil, tank-car lots, 28@34 deg. Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—May 20, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4½c. per gal.; 38@40 deg. 5½c. per gal.

Pittsburgh—May 23, f.o.b. local refinery, 30@34 deg., fuel oil, 5⅜c. per gal.; 36@40 deg., fuel oil, 5½c. per gal; 34 deg., neutral, 8½c. per gal.

Dallas—May 23 f.o.b. local refinery, 26@30 deg., $1.30@$1.35 per bbl.

Philadelphia—May 16, 28@30 deg., $2.31@$2.373 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.785@$1.848 per bbl.

Boston—May 20, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¾c. per gal., light oil, 28@32 deg., Baumé, 6¾c. per gal.

Cincinnati—May 19, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5½c. per gal.; 26@30 deg., 5¾c. per gal.; 30@32 deg., 6c. per gal.

New Plant Construction

Ala., Bessemer—The Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa., plans for a steam power house at its proposed firebrick and refractory plant near the city, with cost of entire project $250,000, including equipment.

Ala., Birmingham—The One Minit Cereal Corp., recently organized, plans for a boiler plant at its proposed factory. Entire project to cost $300,000. H. M. Woodruff, president.

Ala., Crichton—The Mobile Paper Mills, Mobile, Ala., are arranging for a boiler house at their new paper mills. Contracts for equipment will soon be placed. J. M. Walsh, president.

Ark., Fayetteville—The Crystal Ice & Ice Cream Co. plans for a new plant on North West St., with power house provided with oil engines, horizontal tubular boilers and auxiliary equipment. Machinery in the main plant will be motor-driven. The project involves about $80,000.

Ala., Florence—The United States Engineer will take bids until June 14, for operating machinery for regulating gates at the Wilson dam, Tennessee River, as specified in Circular 504.

Calif., Auburn—The Bear River Power Co. has made application to the State Department of Public Works, for permission to use waters of the Bear River for a proposed hydro-electric plant with capacity of 43,000 hp.

Calif., Los Angeles—The New Process Laundry Co., East Thirty-first St., is planning for boiler plant. A. Godfrey Bailey, Junior Orpheum Bldg., architect.

Calif., Modesto—The Modesto Irrigation District has secured permission from the State Department of Public Works to use waters from the Tuolumne River, Stanislaus County, for a hydro-electric development of 19,200 hp., to cost $360,000.

Calif., Oakland — The Great Western Power Co., 14 Sansom St., San Francisco, has plans and will start soon on a combination steam-heating plant and electric power substation at Twentieth St. and Telegraph Ave. Cost $425,000.

Calif., Oxnard—The Ord Ice Co. plans for two additions to its ice-manufacturing and refrigerating plant to cost $100,000. It will include a 150-ton refrigerating plant; 75-ton ice-making machine; and 200-hp. natural gas-operated engine unit, with auxiliary equipment. Jack Miller, general manager.

Calif., Oxnard—The Union Ice Co., has purchased property near First St., for a new ice-manufacturing plant. Plans will be prepared soon.

Calif., San Francisco—The California-Oregon Power Co., 454 California St., has secured permission to issue securities for $5,000,000, for a hydro-electric plant on the Klamath River with capacity of 25,000 kw., supplementing its present station. The entire output will be used by the Pacific Gas & Electric Co.

Calif., San Francisco—The Electro Metals Co. has permission from the State Department of Public Works to use waters from the Klamath River, Humboldt County, for a hydro-electric development approximating 103,300 hp. Cost placed at $8,000,000.

Calif., Redondo — The Board of City Trustees has authorized pumping equipment for the sewerage works, to replace present worn-out apparatus. William Thompson, street superintendent in charge.

Calif., Turlock—The Turlock Irrigation District has received permission from the State Department of Public Works to use waters from the Tuolumne River for a proposed hydro-electric development to total 22,540 hp. Cost $480,000.

Del., South Wilmington—The Hearn Oil Co., Wilmington, plans for an oil storage and distributing plant, with pumping equipment, on site acquired from the Bethlehem Steel Co. Cost $100,000. Claude P. Hearn, president.

Fla., Anna Maria—The Board of Town Commissioners plans for a municipal electric light plant. It is also purposed to install a municipal ice-manufacturing plant. Estimates of cost are being made.

Fla., Davenport—The Common Council is planning for centrifugal pumping equipment for proposed extensions and improvements in the waterworks.

Fla., Palatka—The Common Council is considering electric-operated pumping equipment for proposed extensions in the water and sewerage systems. Bonds issues of $40,000 in each case are being arranged.

Fla., St. Petersburg—The Pinellas County Power Co. plans for a steam generating plant in the Bayboro district, and will commence foundation work soon. A contract for power house superstructure has been let to the Tampa Shipbuilding & Engineering Co., Tampa, Fla. The new station will cost $800,000. B. M. Latham, general manager.

Fla., Tampa—The City Commission will receive bids until June 24 for waterworks buildings and equipment, including 2 low and 2 high lift steam-turbo-centrifugal pumping units; 2 motor-driven centrifugal pumps; horizontal water-tube boilers, with oil burners and fuel oil storage; 2 elevated steel tanks and towers 500,000 gal. capacity, each; and 1 elevated steel tank and tower, 100,000 gals. capacity; radial brick stack; valves, piping, etc., all as per plans and specifications at the office noted, or at the office of Nicholas S. Hill, Jr., 112 East Nineteenth St., New York, consulting engineer.

Ga., Acworth—The Acworth Cotton Mills are planning for a 50,000-gal. steel water tank on 60-ft. steel tower.

Ga., Brunswick—The Lang Planing Mills are planning for a boiler plant in connection with the proposed rebuilding of the portion of their lumber mill recently burned with loss of $45,000, including equipment.

Ga., Lindale—The Atlantic Ice & Coal Corp., Rome, Ga., plans for a new cold storage plant on site recently acquired.

Idaho, McCall—The Board of Directors, Lake Irrigation District, plans for pumping equipment for an irrigation project to cost $120,000. Bonds have been voted.

Ind., Indianapolis—The Board of Trustees, General Protestant Orphan Association Home, 1404 South State St., will take bids at once for a new power plant and other operating buildings at the institution, estimated to cost $100,000. Vonnegut, Bohn & Mueller, Indiana Trust Bldg., architects.

Ind., Lawrenceburg—The Union Gas & Electric Co., Cincinnati, Ohio, will soon begin construction on its steam electric generating plant on the Big Miami River. A general contract for foundations and steel superstructure has been awarded to the Foundation Co., 120 Liberty St., New York. The installation includes a coal storage plant, 500,000 tons capacity, conveying machinery, coal and ash-handling equipment. A brick stack will be built. The entire project involves $13,000,000.

Iowa, Marshalltown—The Water Works Department, A. T. Luce, superintendent, plans for extensions and improvements in the municipal water plant, to include a new pumping station, tank and auxiliary equipment, to cost $150,000.

Kan., Garnett—A portion of the municipal electric light and power plant was destroyed by fire, May 15, with loss estimated at $75,000, including equipment. Tentative plans for rebuilding are under consideration by the Common Council.

Kan., Lyons—The American Salt & Coal Co., Waldheim Bldg., Kansas City, Mo., plans for a steam plant at its proposed salt evaporating plant. The entire project to cost $850,000.

Ky., Clifton—The Common Council is considering centrifugal pumping equipment for proposed extensions in the water system. Bonds have been arranged.

Ky., Owensboro—The Owensboro, Rockport & Chicago Railroad Co., 741 Frederica St., plans for a power plant and a number of automatic power substations, in connection with the proposed electrification of its line to Elnora, Ind., about 85 miles, to cost $6,000,000, complete. Thomas H. Hazelrigg, 1227 West Twenty-ninth St., Indianapolis, Ind., consulting engineer.

La., Baton Rouge—The Texas Chemical Co., Houston, Tex., plans for a plant on site acquired recently. A steam power station will be installed. The entire works to cost $750,000, with machinery.

La., Coushatta—Bids will be received by P. C. McLemore, town clerk, until June 11, for equipment for waterworks and sewerage plants, including one 200 g.p.m. motor or gas-engine driven centrifugal pump; one 50,000 gal. steel tank on 125-ft. tower, and one 75,000 gal. steel tank on 125 ft. tower; valves and auxiliary equipment, all as per specifications on file. E. T. Archer & Co., New England Bldg., Kansas City, Mo., engineers.

Md., Leonardtown—The Common Council has tentative plans for centrifugal pumping equipment for a waterworks plant. Bonds for $35,000 have been voted.

Mass., Springfield — The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., plans to take bids early in June for a boiler house and steam heating plant at its local works, estimated to cost $250,000, with equipment. McClintock & Craig, 33 Lyman St., Springfield, engineers.

Mich., Lansing—The Ingham Gravel Co., recently organized, plans for hydraulic pumping equipment at its properties near the city, totaling about 30 acres. The company is headed by Frank L. Young and L. F. Morrison, both of Lansing.

Mich., Royal Oak—Following a rejection of bids received on May 19 for a sewerage pumping station and disposal works with capacity of 2 m.g.d., the city clerk is calling for new bids on the equipment, to be received until June 10, as per plans and specifications by Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., consulting engineers. P. H. Beauvais, city manager.

Miss., Lyman—The Batson & Hatton Lumber Co., Hillsdale, Miss., plans for a boiler plant at its saw mill. The project will involve $40,000.

Mo., Cape Girardeau—The Union Electric Light & Power Co., plans for additional equipment at its power plant, including water-cooling apparatus. H. B. Newman, manager.

Mo., Hannibal—The Board of Works will receive bids until June 6, for equipment for extensions and improvements in the municipal waterworks, including 9 motor-driven centrifugal pumps, of which 3 will be used for raw water service to have a capacity of 2,500 g.p.m.; 2 for filtered water, 4,200 and 3,150 g.p.m., respectively; 3 for booster service, each 500 g.p.m.; and 1 wash pump, 500 g.p.m.; 2 towers and water tanks; switchboard and accessory apparatus. The Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., engineer.

Mo., Hartville—Fred Johnson, city clerk, will receive bids until June 11, for municipal hydro-electric power plant for the city, consisting of power dam, one 42-kva. alternator, 3-phase, 60-cycle, 2,300-volt, direct-connected to waterwheel; one 25-hp. coal oil engine, belt-connected to a 25-kva. alternator, with switchboard and auxiliary equipment. The Alexander Engineering Co., Woodruff Bldg., Springfield, Mo., engineer.

Mo., Perryville—The Common Council is considering centrifugal pumping equipment for its proposed municipal waterworks and sewerage system. Bonds for $100,000, are being arranged. The Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., engineer.

Mo., St. Louis—The Board of Public Service will perfect plans soon for the proposed union market, to include an ice and cold storage plant. A fund of $1,000,000 is available for the structure. The Market Construction Co., Cleveland, Ohio, advisory engineer for the project.

Mo., St. Louis—The Steelcote Mfg. Co., 700 North First St., manufacturer of paints, is planning for a boiler house at its proposed plant, to cost $400,000.

Mont., Big Fork—The Mountain States Power Co., Sandpoint, Idaho, will begin work soon on an addition to its hydro-electric plant, including a new generator and auxiliary equipment, to cost $100,000.

N. J., Morristown—The Board of Aldermen has tentative plans for electric-operated pumping equipment at the city waterworks to replace existing steam-driven apparatus.

N. M., Tucumcari—The city clerk is taking bids until June 14 for equipment for a municipal waterworks, including pumping machinery, valves, and auxiliary apparatus, as per plans and specifications on file, or at the office of the Weiland Engineering Co., Thatcher Bldg., Pueblo, Colo., engineer.

N. Y., Auburn—The Board of Trustees, Mercy Hospital, plans for a new institutional building and steam power plant at West Auburn. The project to cost $500,000. S. E. Hillger, Seward Bldg., architect.

N. Y., Brooklyn—A steam power plant will be installed in the municipal building, to be erected by the city at Court and Joralemon Sts., to cost $6,000,000. Bids are being asked on a general contract until June 14. McKenzie, Voorhees & Gmelin, 345 Madison Ave., New York, architects. Clark, McMullin & Riley, 101 Park Ave., New York, steam and electric engineers.

N. Y., Buffalo—The Hendon Chemical Co., care of the Combustion Utilities Co., 8 Bridge St., New York, engineer, plans for a boiler house for its proposed plant on the River Road, consisting of a number of units. It will cost $500,000, complete. Work to begin during the summer.

N. Y., Fulton—Bids will be received by H. S. Andrews, Commissioner of Public Works, until June 6, for one complete pumping unit, to be horizontal, cross-compound condensing crank and flywheel type, with rated capacity of 4,000,000 g.p.d., as per specifications on file.

N. Y., Providence—The Board of Supervisors of Saratoga County, Saratoga Springs, J. R. Whitney, clerk, is taking bids until June 17, for a hydro-electric plant, pumping station, elevated steel tank and auxiliary equipment for service at the local Homestead Sanitarium. The Utilities Engineering Co., 467 Broadway, Albany, N. Y., engineer.

N. Y., Watertown—The Northern New York Utilities, Inc. has called a meeting of stockholder to approve an increase in capital from $4,000,000 to $10,000,000, part of the proceeds for expansion in generating facilities and lines.

N. C., Chimney Rock — The Chimney Rock Mountains, Inc., recently formed to develop a resort in this section, has commissioned Mees & Mees, Charlotte, N. C., engineers, to prepare plans for a power dam and hydro-electric power station at Lake Lure. The complete project to cost $3,000,000. Dr. L. B. Morse, president.

N. C., Durham—The City Council will take bids until June 26, for a combined pumping and power plant for municipal service, as per plans and specifications on file. William M. Platt, Durham, engineer.

N. C., Laurinburg—The Town Council is disposing of a bond issue of $175,000, for extensions and improvements in the waterworks, and additional pumping and other equipment.

N. C., Plymouth—The Town Council has issued bonds for $20,000, for extensions and improvements in the municipal electric light and power plant.

N. C., Wilmington—Oliver Carter, Wilmington, is planning for the purchase of a stationary engine and auxiliary equipment for a local plant.

Ohio, Columbus—A steam power plant will be installed in the proposed office building of the American Insurance Union at Broad, Front, Lynn and Wall Sts., to cost $3,000,000. Plans will be drawn by C. Howard Crane, 542 Griswold St., Detroit, Mich., architect.

Ohio, Elyria—The State Welfare Department, Columbus, Ohio, will soon call for bids for a steam power plant and mechanical laundry for the Grafton Farm institution. An appropriation of $500,000 is available. The state architect has plans in preparation. John E. Harper is director of the welfare department.

Ohio, Portsmouth — The Linde Air Products Co., 30 East Forty-second St., New York, is planning for a boiler house at its proposed plant on Thirty-eighth St. The entire works to cost $100,000.

Okla., El Reno—The Crystal Laundry Co., 108 Choctaw Ave., plans for a boiler house, in connection with a number of new additions, to cost $30,000.

Okla., Elk City—The Inland Utilities Co., recently organized, has secured a local franchise for light and power service, and plans for a steam electric plant, with distributing system.

Okla., McAlester—The Southwest Power Co., recently formed to take over and merge the Choctaw Power & Light Co., with plant in this section, and the Coal District Power Co., has arranged for a bond issue of $2,100,000, a portion to be used for the acquisition of the properties and consolidation, and for extensions and improvements in plants and system.

Ore., Bend—The Columbia Valley Power Co. will begin work on a new hydro-electric plant on the Deschutes River, including a power dam, 140 ft. high, and station equipped for a maximum output of 160,000 hp.

Pa., Brockwayville — The Brockway Crystal Water Co., has been ordered by the State Board of Public Service Commissioners to make extensions and betterments in its system, to include a 20,000-gal. tank and other equipment. Work to be completed by December.

Pa., Elizabethtown — The Borough Council has rejected bids received and will have revised plans drawn for sewerage disposal plant and system, with pumping station, to cost $250,000, complete; new bids will be asked soon. J. Harvey Buch, president of the council, in charge.

Pa., Holtwood—Officials of the Pennsylvania Water & Power Co., are organizing a new subsidiary with capital of $3,500,000, to construct and operate a steam-electric generating plant, to have an initial capacity of about 20,000 kw. and to cost $2,000,000. Additional units will be installed later to increase the output to 100,000 kw. J. E. Aldred of J. E. Aldred & Co., 42 Wall St., New York, head of the Pennsylvania company, heads the new organization.

Pa., Philadelphia—The Board of Trustees, Children's Home Hospital, Franklin and Thompson Sts., has tentative plans for a steam power house at the institution.

Pa., Philadelphia—The Supply Officer, Navy Dept., has been authorized to purchase two acetylene pressure generators, as specified in N. S. A. Requisition 962.

Pa., Pottsville—The City Council plans for a sewerage disposal plant and system, with centrifugal pumping equipment. Bids will be asked for soon. Banks & Craig, Telegraph Bldg., Harrisburg, Pa., engineers.

Tenn., Lewisburg—The Board of City Commisioners is receiving bids until June 19, for extensions in the water supply system, including pumping plant, impounding dam, etc., as per plans and specifications on file. Paul H. Norcross, Candler Bldg., Atlanta, Ga., consulting engineer.

Tenn., Morristown—The Common Council has disposed of a bond issue of $300,000 and plans for extensions and improvements and additional equipment to the municipal electric plant, and like expansion at the waterworks.

Tex., Austin—The Tips Engine Works, Inc., is planning for the purchase of an air compressor-engine set, direct-connected, for its plant.

Tex., Claude—The Common Council is arranging a bond issue of $35,000 for a municipal electric power plant. Centrifugal pumping equipment is contemplated for extensions in the waterworks system, for which another bond issue of $35,000 will be voted.

Tex., Gilmer—The Common Council contemplates centrifugal pumping equipment for extensions in the waterworks, to cost $25,000.

Tex., Malakoff—The Texas Power & Light Co., Dallas, has acquired a tract of local lignite properties, and is perfecting plans for the construction of a steam-electric power plant.

Tex., Troup—R. J. Irvine, Troup, plans for the organization of a company, to construct and operate an ice-manufacturing plant. A site has been selected.

Wash., Longview — The Long-Bell Lumber Co. is planning for additional pumping equipment for extensions in the sewerage system.

Wash., Vader—The Common Council plans for a pumping plant on the Olequa River for water service.

W. Va., Beckley—The City Council plans for centrifugal pumping equipment for a new waterworks and system. Bonds will be arranged at an early date.

W. Va., Bluefield—C. W. Hancock & Son have inquiries out for an air compressor, portable type, gasoline operated.